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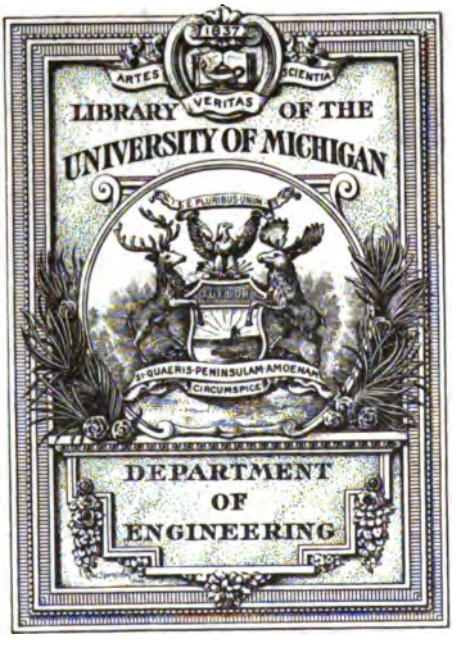

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WORLD'S FAIR SOUVENIR

OF THE

ENGINEERS' CLUB

OF SAINT LOUIS

1904

INTRODUCTION.

At the time of the World's Fair in Chicago, 1893, the Engineers' Club of St. Louis prepared a pamphlet entitled "Engineering Works of St. Louis and Its Vicinity, of Interest to Visiting Civil, Mining, Mechanical and Electrical Engineers." This was intended to be of use to visiting engineers who might come to St. Louis during the Exposition.

In the same year the Engineers' Club published a book of Local Engineering Data for St. Louis, intended for the benefit of its members. This work was a record of available engineering data peculiar to the City and its environs.

In this year of the Louisiana Purchase Exposition, the Club issues this book for the benefit of its members and of the large number of engineers who are expected to visit St. Louis.

This book is to cover the ground of the two publications above mentioned, with the addition of a section devoted to the Louisiana Purchase Exposition, and a section for the Engineers' Club of St. Louis.

The members of the committee desire to express their obligations to the members of the Club who have assisted them, and without whose help this work could not have been accomplished.

DIVISION I.

WORLD'S FAIR SECTION

Sub-Committee in Charge:
H. A. WHEELER.
J. A. OCKERSON.

189019

THE
St. Louis World's Fair

HISTORICAL

By H. A. Wheeler.

History of St. Louis World's Fair.

THE St. Louis World's Fair commemorates the centennial of the first important expansion in the development of the United States, or the purchase, under President Jefferson, of the Louisiana Territory for $15,000,000 from France, while Napoleon was warring with England. This territory contains 1,037,735 square miles, extending from the Gulf of Mexico to Canada, and from the Mississippi to the Rocky Mountains, and includes fourteen States and Territories. It had previously been ceded by Spain to France, and at the time of its purchase it was a wild, trackless Indian country with only a few thousand white inhabitants. At the close of its first century the population had grown to about 15,000,000 and the taxable wealth to $6,616,000,000. St. Louis is the largest city in the Louisiana Purchase, with a population, including its suburbs, of about 600,000, and is the fourth city of the United States. Twenty-two trunk lines radiate from the Union Depot, while its river system affords steamboat navigation 900 miles north to St. Paul, 800 miles east to Pittsburg, 1000 miles south to New Orleans and 1000 miles west to Bismark.

THE SITE

The Site of the St. Louis World's Fair.

The site of the World's Fair is in the western part of the city, about five miles west of the Mississippi River, and contains, in a solid tract, 1,263.49 acres, that is approximately two miles east and west by one and one-fourth miles north and south. Of this, 657 acres consists of the western portion of Forest Park (the largest of the city parks), 545 acres west of the park is leased from Washington University and other estates, and 61 acres north of the park is leased for "The Pike." When work was begun in December, 1901, this tract mainly consisted of heavy rolling, forest-covered land, through which meandered a sluggish, treacherous river known as the Des Peres. There was from 75 to 125 feet variation between the hills and sharp dales, while an artificial lake occupied the sites of the Mining, Liberal Arts and Manufactures Buildings. To lower the hills and grade up the valleys has required the moving of 2,000,000 cubic yards

The Site of the St. Louis World's Fair.

of earth, the lake has been piled over and the meandering River Des Peres has been confind within a box flume 45 feet wide by 15 feet deep, over which is the central promenade of the Exposition. While much of the old virgin oak forest has had to be sacrificed, quite large maples and elms have taken their place, as the result of a new system of tree transplanting. A lagoon 1½ miles long, with 3½ to 5 feet depth, of water encircles the Electricity and Education Buildings and affords access by gondola and electric launches to the nine main buildings that form the principal picture of the Exposition.

An intramural tramway, provided with 17 stations, encircles the entire grounds, and consists of a double track trolley system seven miles long.

For facilitating construction and the installation of 12,000 carloads of exhibits, it was necessary to lay 15 miles of additional track through the grounds, besides extensive storage tracks in the western part of the grounds.

GENERAL FEATURES OF THE EXPOSITION

General Features of the Exposition.

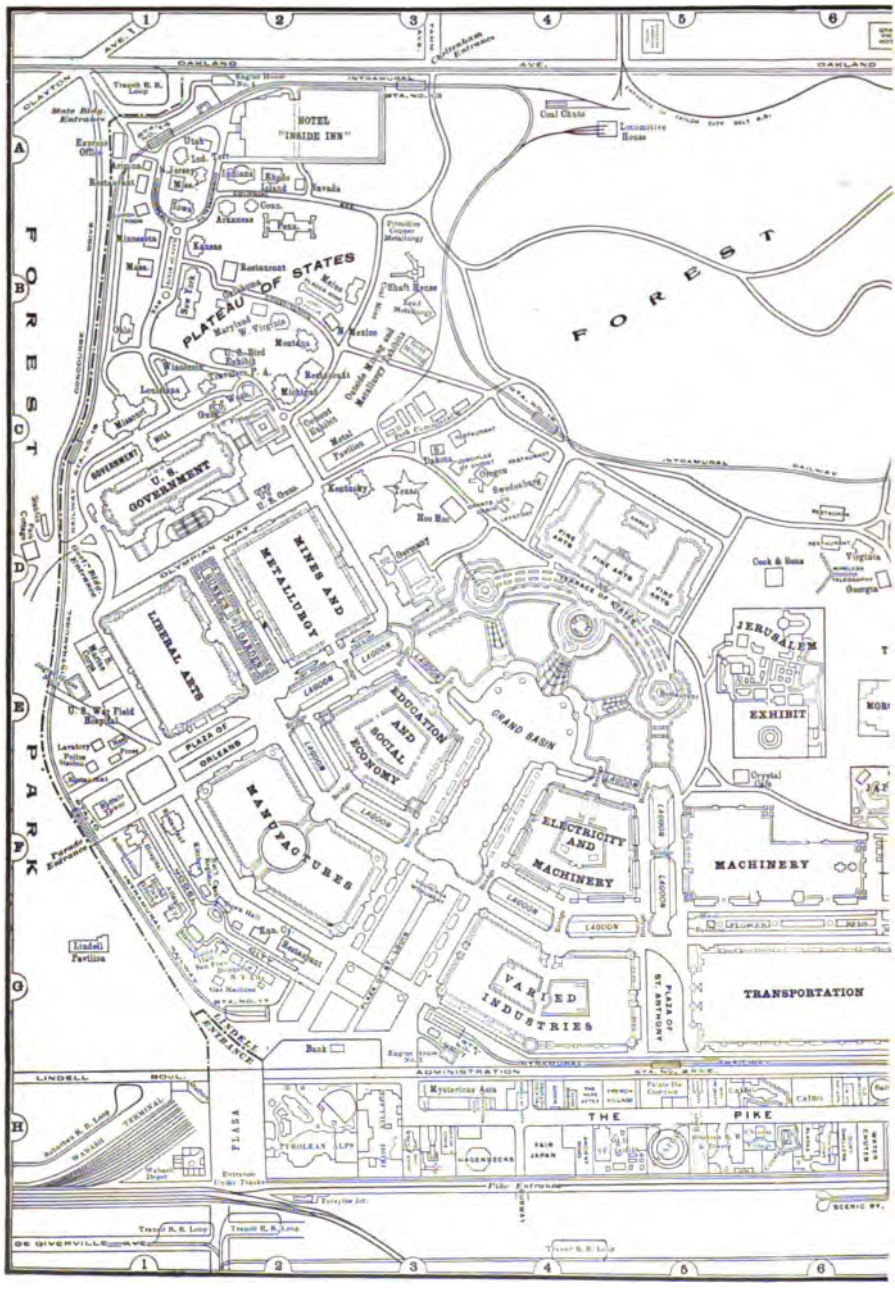
The main picture of the Exposition centers around **Festival Hall** (200 feet high), at the head of the Grand Basin, an architectural masterpiece by Cass Gilbert. From this pour the three Cascades, with 94 feet fall, into the Grand Basin. This water is repumped from the lagoon by three Worthington centrifugal pumps, each of 35,000 gallons capacity per minute and driven by 2000 h.p. motors. A curved colonnade flanks each side of Festival Hall, terminating in a restaurant pavilion at each end, with heroic statues symbolizing the fourteen States of the Louisiana Purchase occupying intervening alcoves.

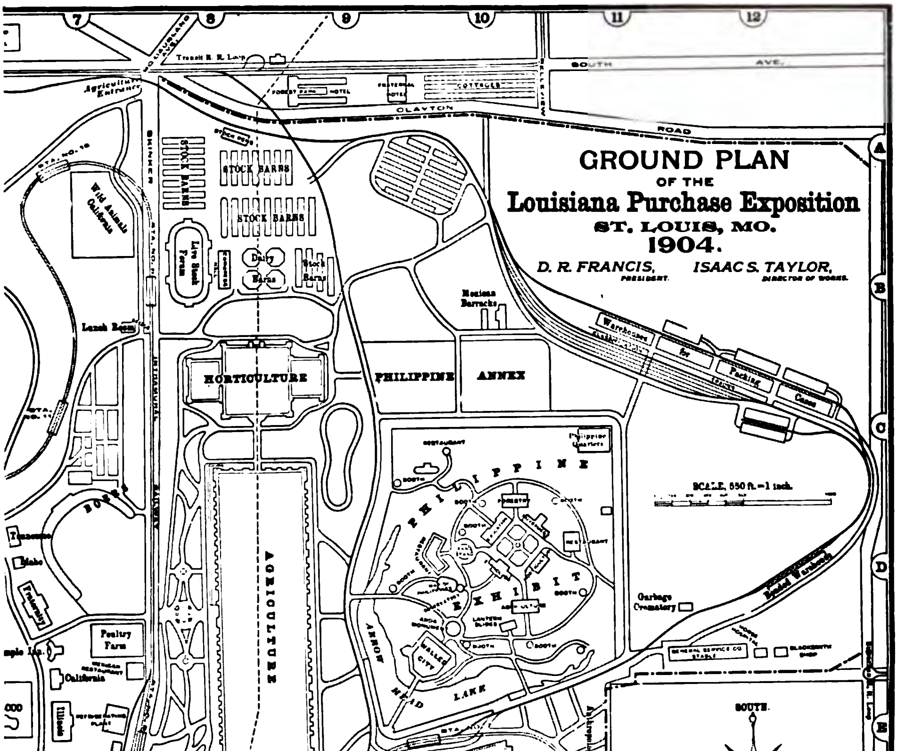
The **Art Building** (450 by 830 feet), behind or south of Festival Hall, is to be the permanent monument of the Exposition. It is constructed of brick, stone and terra cotta, at a cost of $1,000,000; designed by Cass Gilbert, of St. Paul.

Radiating from the front of Festival Hall and on a plane some sixty feet lower are the following main buildings of the Exposition:

To the extreme right and marking the eastern end of the grounds is the **Government Building** (250 by 800 feet; cost $450,000), a dignified, classic structure, designed by J. Knox Taylor, of Washington, in which all the different departments of the government are exhibited. Huge guns are shown on the adjacent terraces, and the **Fisheries Building** (135 by 135 feet), adjoins on the south.

The **Mining and Metallurgy Building** (525 by 750 feet, covering 9 acres; cost $500,000), designed by Theo. Link, of St.


HOTEL "INSIDE INN"
PLATEAU OF STATES
FOREST
U. S. GOVERNMENT
MINES AND METALLURGY
LIBERAL ARTS
EDUCATION AND SOCIAL ECONOMY
MANUFACTURES
ELECTRICITY AND MACHINERY
VARIED INDUSTRIES
MACHINERY
TRANSPORTATION
JERUSALEM EXHIBIT
GRAND BASIN
THE PIKE
FOREST PARK
OAKLAND AVE.
ADMINISTRATION
PLAZA OF ST. ANTHONY
PLAZA OF ORLEANS
LINDELL BOUL.
DE GIVERVILLE AVE.


GROUND PLAN
OF THE
Louisiana Purchase Exposition
ST. LOUIS, MO.
1904.
D. R. FRANCIS, PRESIDENT.
ISAAC S. TAYLOR, DIRECTOR OF WORKS.
SOUTH AVE.
CLAYTON ROAD
STOCK BARNS
Live Stock Forum
Dairy Barns
Stock Barns
Mexican Barracks
Wild Animals California
HORTICULTURE
PHILIPPINE ANNEX
PHILIPPINE EXHIBIT
Warehouses for Packing Cases
AGRICULTURE
ARROW HEAD LAKE
Walled City
Garbage Crematory
Poultry Farm
California
Illinois
Lincoln Exhibit
U. S. Life Saving Exhibit Lake
Outside Exhibit U. S. Bureau of Plant Industry
SOUTH.
EAST.
WEST.
NORTH.
NURSERY
Missouri Game
FORESTRY FISH & GAME
FRANCE
OLYMPIAN WAY
BARRACKS AND PARADE GROUNDS
ATHLETIC FIELD
PHYSICAL CULTURE
GREAT BRITAIN
Italy
Holland
AUSTRIA
AERONAUTIC CONCOURSE
Naval Exhibit
INTRAMURAL
Administration Entrance
CITY LIMITS
Transit R. R. Loop
Suburban R. R. Loop
ST LOUIS & SUBURBAN RAILWAY
BOILER HOUSE

General Features of the Exposition.

Louis, on unique lines with towering obelisks, fronts the Government Building, and its 25 acres of outside working exhibits lie in the adjoining gulch that runs at the base of the Plateau of States.

The **Liberal Arts Building** (525 by 750 feet, covering 9 acres; cost $450,000), designed by Barnett, Haynes and Barnett, of St. Louis, is in front of the Mining Building, with an intervening sunken garden. In this building are the civil engineering exhibits.

West of the Mining Building and surrounded by the lagoon is the **Education Building** (525 by 750 feet, covering 9 acres; cost $400,000), one of the purest and most dignified designs in classic architecture on the grounds, designed by Eames & Young, of St. Louis.

Fronting to the north is the **Manufactures Building** (525 by 1200 feet, covering 12 acres; cost $850,000), which lies between the Plaza of Orleans on the east and the Grand, or Plaza of St. Louis, on the west, with a most imposing entrance on the south side. Designed by Carrère & Hastings, of New York.

On the opposite side of the Grand Plaza is the **Varied Industries Building** (525 by 1200 feet, covering 12 acres; cost $610,000), with its impressive swinging colonnade facing the western lagoon. Designed by VanBrunt & Howe, of Kansas City.

Facing the west side of the Grand Basin and surrounded by the lagoon is the **Electricity Building** (525 by 750 feet, covering 9 acres; cost $400,000). Designed by Walker & Kimball, of Omaha.

West of the Electricity Building is **Machinery Hall** (525 by 1100 feet, covering 12 acres; cost $600,000), with its numerous towers, designed by Widmann, Walsh & Boisselliene. Adjoining to the west is the **Boiler House**, a fire-proof structure covering 2½ acres (525 by 525 feet).

North of Machinery Hall and fronting on The Pike is the **Transportation Building** (525 by 1300 feet, covering 15 acres; cost $700,000), designed by E. L. Masqueray. This building forms the extreme western end of the main group or principal picture.

Fronting 4000 feet along the north side of the grounds and extending 2000 feet along the Skinker Road is **The Pike**, with its concessions and amusements, of which the **Tyrolean Alps**, at the main or Lindell entrance, is especially noteworthy in its faithful and beautiful reproduction of an Alpine village (at a cost of $600,000).

Fronting on the west side of the Skinker Road are the foreign government buildings, while on a commanding terrace are the dignified Tudor-Gothic granite buildings of Washington University that have been leased for the Administration offices.

As architectural studies of all nationalities this group is most interesting.

General Features of the Exposition.

South of the Administration offices is the **Forestry, Fish and Game Building** (400 by 600 feet), and farther south, on a rising slope, is the **Agricultural Building,** the largest on the grounds (500 by 1600 feet, covering 20 acres; cost $800,000), designed by E. L. Masqueray. Adjoining it is the **Horticultural Building** (300 by 1000 feet; cost $200,000), and the huge **Live Stock Pavilions,** covering 40 acres.

In the extreme western part of the grounds is the **Athletic Stadium,** seating 27,000, and at Intramural Station No. 7 is the **Philippine Exhibit,** a most interesting and complete exhibit of our new colonies that occupies 42 acres and cost over $1,000,000.

The military camps, garbage crematory, barns, storage warehouses, etc., are in the southwestern corner of the grounds.

In the southern part of the grounds is a remnant of the fine old oak forest that covered the major portion of the Exposition site three years ago.

In the southeastern portion of the Exposition is the **Plateau of States** and the huge **Inside Inn** (400 by 800, accommodating 6,000). The various State buildings present a variety of architectural studies and historic reproductions, some of which are very attractive. The **State of Washington** building is noteworthy for the eight Oregon pine timbers which inclose it, that are 2 feet by 2 feet by 110 feet clear sticks of timber, and opposite is the **Aviary** or **"Bird Cage,"** a huge cage 300 feet long occupied by a rich collection of birds.

Conspicuous by their height, and affording a fine view of the Exposition and St. Louis, are the **Observatory Tower,** 260 feet high, in the northeastern corner of the grounds, and the **Ferris Wheel,** 250 feet in diameter, on the Skinker Road and adjoining the Boiler House in the western part.

FINANCING THE EXPOSITION

Over $50,000,000 Invested in the Exposition.

The Exposition represents a plant investment somewhat greater than $50,000,000, which vastly exceeds the outlay at any previous World's Fair. The initial fund of $15,000,000 for the exhibit buildings and grounds represents the amount given 101 years ago for the Louisiana Territory, or at a rate of somewhat less than $15 per square mile. This preliminary fund was raised by stock subscriptions by St. Louisans to the amount of $5,000,000, $5,000,000 more from the City of St. Louis by the sale of bonds, and $5,000,000 donated by Congress to celebrate this important historical event. Congress also appropriated about $3,000,000 for exhibits, and still more recently advanced, as a loan, $4,600,000, to complete the work. The different States have appropriated about $7,000,000 for the State exhibits (Missouri

Panorama of the World's Fair.

PANORAMA OF THE WORLD'S FAIR.

appropriating $1,000,000), and foreign governments over $5,000,000. The Pike and its accessories represent an investment of about $5,000,000, while exhibitors have expended from $1 to $5 per square foot on the 128 acres of exhibits.

Over $50,000,000 Invested in the Exposition.

The following comparison clearly brings out the enormous growth of the St. Louis World's Fair over previous noteworthy Expositions:

Compared with Other Expositions.

	Size. Acres.	Area. Under Roof, Acres.	Illumination, Electric Lights.	Cost.
St. Louis (1904)....	1263	300	210,000	$50,000,000
Chicago (1893).....	633	194	102,000	28,000,000
Paris (1900).....	336	117	76,720	22,000,000
Buffalo (1901).....	300	15	.....	6,000,000
Philadelphia (1876)..	236	62	.....	.....

ENGINEERING DATA

The following data concerning the engineering features of the Fair are furnished by Richard H. Phillips, Chief Engineer of the Louisiana Purchase Exposition Co.:

Roads.

A total area of 5,800,000 square feet has been paved. This is covered with burnt ballast, gravel, macadam, asphalt and brick. Of this about 500,000 square feet has been covered with brick, 800,000 square feet with asphalt, and the balance with macadam, gravel and burnt ballast. This is equal to about 55 miles of road 25 feet wide.

Water Supply.

Twenty-one miles of pipe have been laid for the water supply. They vary in size from 12-inch to 2-inch, forming a network over the entire grounds and inside of the buildings. The supply is drawn from the city mains, there being a 36-inch main along the east side of the World's Fair site in Forest Park, a 12-inch main along Lindell Boulevard and a 12-inch main along Skinker Road, to which the Exposition system is connected.

Fire Protection.

About 36 miles of pipe for high pressure fire protection system have been installed. This covers the Exposition grounds and main exhibit buildings.

In addition to this, each State, foreign and concession building has been required to install its own system of pipe for fire protection, connecting the same to the Exposition mains. These systems for smaller buildings include hose, hose connections, hose racks, standpipes and hydrants.

The Exposition has a total of 530 fire hydrants on the high pressure system, and 31 deck turrets for protection of the main exhibit buildings.

Five engine houses have been constructed and are fully equipped with engines, hose trucks and other necessary adjuncts.

In addition to this, Hale's Company of Fire Fighters, from Kansas City, have installed a double company with full equipment and are subject to fire duty. (At west end of Pike.)

Fire Protection.

Hose is also attached to each fire hydrant inside the buildings and to roof connection on roofs of the buildings.

The high pressure mains are laid about 100 feet from the four sides of the main exhibit buildings and the hydrants are spaced 150 feet apart. The interiors of the exhibit buildings are protected by hydrants spaced 150 feet apart.

Water for fire fighting purposes is supplied from a reservoir in the western part of the site. This contains 6½ million gallons of water.

Two 12-inch connections are also made to the city main in order to have two sources of supply.

Pressure is maintained at 150 pounds per square inch by means of fourteen 1000 gallon capacity Underwriters' fire pumps.

Pipe for high pressure system for roofs, the inside and outside of buildings, is wrought iron, tested to 750 pounds per square inch. The entire fire pipe system after installation was subjected to a test of 300 pounds per square inch.

In high towers and under the elevated portions of the floor of the Art Buildings, sprinkler systems have been installed. Pipes for the sprinkler systems are connected with high pressure pumps and also have steamer nozzle connections outside the buildings. Numerous chemical fire extinguishers are placed at convenient points about each building.

Storm Water Drains.

In addition to the main waterway of the River Des Peres, which is about one mile long, 25 miles of storm water drains have been constructed.

In order to avoid placing the main exhibit buildings over the river channel, which pursued a tortuous route through the site, a new channel was excavated and lined with timber. This channel was made to traverse the main streets between the buildings and shortened the stream from 8800 feet to a more direct route of 4650 feet.

Numerous obstructions, in the way of trestle bridges, short bends in the channel, etc., below the World's Fair site in Forest Park, were removed in order to provide sufficient area for storm water and prevent overflow, such as occurred in previous years.

All storm water drains, including roof drains from buildings, discharge into the main channel of the River Des Peres, except downspouts from the east end of the Mines Building and from the Education and Electricity Buildings, the latter two being situated on islands surrounding by lagoons.

Lagoons and Lakes.

The lagoons which surround the Education and Electricity Buildings in the center of the main picture have an area of 750,000 square feet and contain 20,000,000 gallons of water, the depth varying from 3½ feet to 5 feet. Electric launches and gondolas are thereby afforded a continuous trip of 1½ miles.

Lagoons and Lakes.

The lagoons are provided with eight feed pipes from water mains of such capacity that the entire lake can be filled in 40 hours.

A filter plant at the southwest corner of the Mining Building is designed to supply the loss from seepage and evaporation and will be operated continuously during the life of the Fair.

Arrowhead Lake, some 2000 feet in length and varying in width from 100 feet to 250 feet, and 4 to 12 feet deep, will be used by water craft of the Philippine Villiage.

The Life Saving Lake, situated east of the Ceylon Building, will be used by the U. S. Government for life saving exhibitions, the life saving station being situated at the east end of the lake. This lake is 480 feet long, varying in width from 100 feet to 150 feet, and giving a depth of water of from 4 feet to 12 feet. This lake contains about 3,600,000 gallons of water.

A system of overflows is installed, also a system of end drains, so that the entire lake can be drained when required and refilled with fresh water as often as required.

Smaller lakes are constructed in the Philippine Reservation, east of the Agriculture Building and U. S. Government Bird Cage, besides a number of smaller lakes in the concessions district.

Sanitary Sewers.

A system of sanitary sewers has been constructed to discharge by gravity into two wells in the eastern end of the grounds near the Mines Building, from which sewage is pumped into the city sewer mains, a distance of 3,650 feet, through a cast iron main.

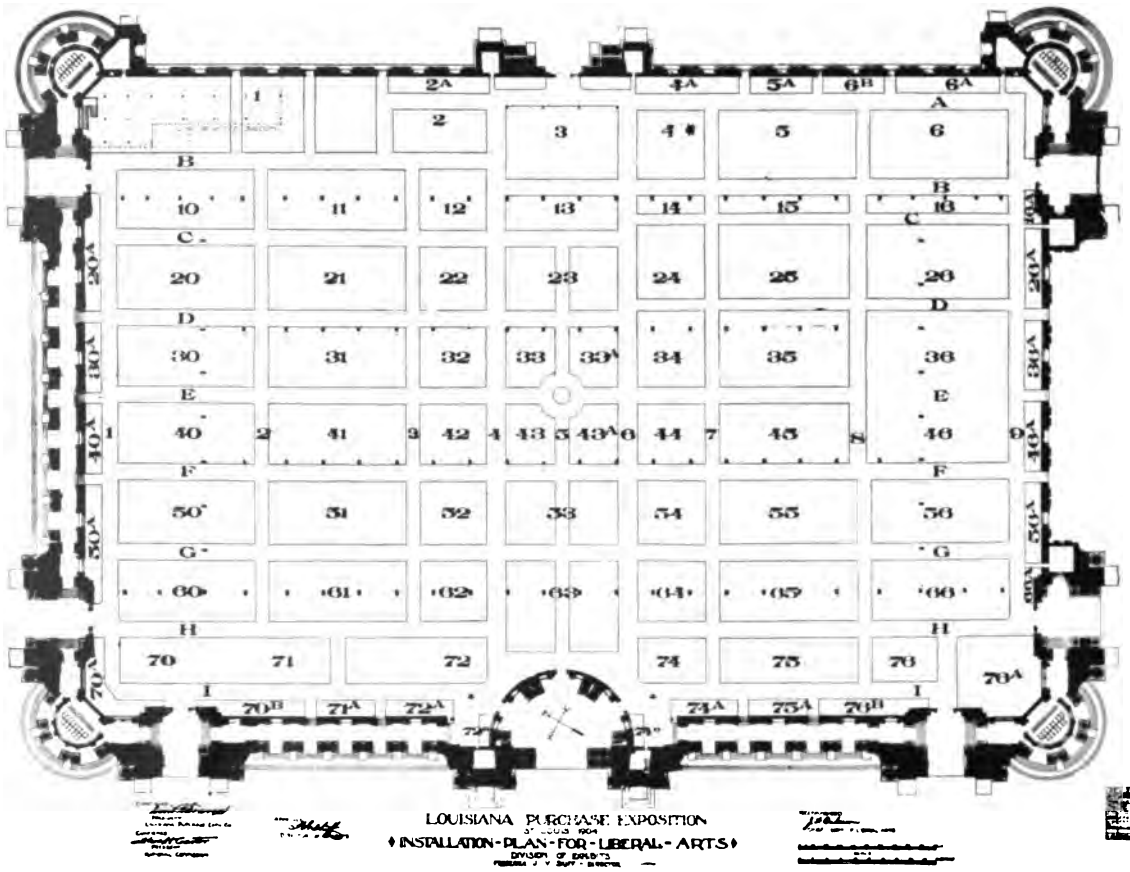
Four electrically driven centrifugal pumps, of 18 million gallons capacity, have been installed for this service. Two pumps are installed in each well and connected to mains so that sewage can be pumped directly from the main sewers, or from the wells as may be desired. One or both wells can be cleaned at the same time that all four pumps are running.

A handsome pavilion is erected over these wells and a room above the pumps used as a motor room.

In addition to the cast iron main, the Exposition has laid 62,000 feet of vitrified pipe mains for sanitary sewers. This does not include pipe installed by the various States, foreign governments and concessions, who are required to install their own systems within their grounds and connect same to the Exposition mains.

Garbage Plant.

A garbage crematory has been erected northwest of the Philippine site, where combustible debris and garbage are taken care of; the moist garbage is deposited in cans at the buildings and is removed at night. Combustible street sweepings are also taken to the garbage plant, being cared for in sacks made especially for this purpose.


LOUISIANA PURCHASE EXPOSITION
INSTALLATION - PLAN - FOR - LIBERAL - ARTS

Streets and buildings are swept at night and all except combustible material is hauled away to dumps in the western portion of the grounds.

THE ENGINEERING EXHIBIT BUILDINGS

The Engineering Exhibit Buildings.

The following five buildings are especially rich in engineering exhibits, and the brief list given of the more important exhibits is intended to call attention to displays that should not be overlooked by the engineer whose time is very limited. Each of the buildings contains many more exhibits that are of interest to the engineer, which are warmly commended to the visitor who has the time to inspect and study them.

LIBERAL ARTS BUILDING

By J. A. Ockerson.

Location of Exhibits in the Palace of Liberal Arts of Special Interest to Engineers.

In Block No. 33 is located the exhibit of the American Society of Civil Engineers; near it is a model of Southwest Pass Lighthouse, instruments of precision and other matters relating to engineering.

In Block No. 54 is the exhibit of the Chicago Drainage Canal, the Minneapolis Engineering Society, the Phoenix Bridge Co., and models, plans and maps relating to the Mississippi River, displayed by the State of Louisiana.

In the British section are found models of the Assouan Dam, dredge boats, light ships, lighthouses, and various other engineering structures.

In the French section are illustrations of armored cement construction, models of harbors, docks, plans and drawings of bridges, and publications and reports of the French Society of Civil Engineers.

In the German section are exhibits illustrating by means of models, plans and drawings, works relating to city engineering, filtration plants, bridges, harbor works, and many other features of special interest.

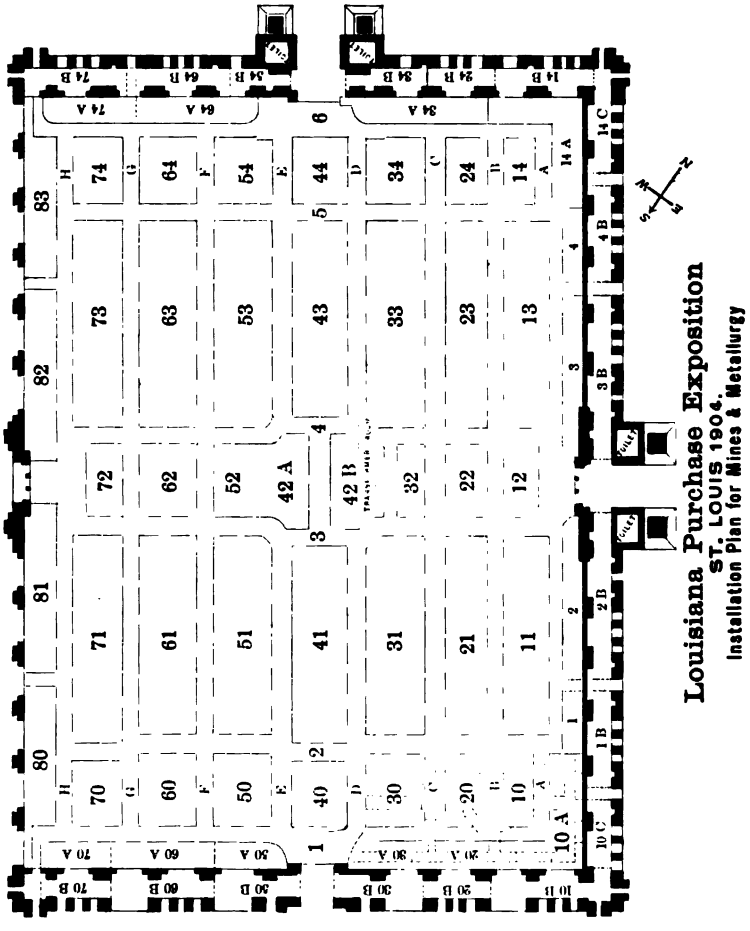
In Block No. 22 is the engineering exhibit of Argentine Republic, including models of harbor works, irrigation canals and other matter.

Opposite this, in Block No. 21, there are exhibits from Egypt illustrating modern and ancient methods of irrigation, models of the Suez Canal, and ancient documents relating to early engineering work in that interesting country.

In Block No. 64 are exhibits from Brazil, some of which relate specifically to engineering.

In the Chinese exhibit in Blocks Nos. 4, 5 and 6, are displays of boats, dwellings and other structures peculiar to China, and all of a character very little known to the people of the western countries.

Installation Plan for Mines and Metallurgy.



MINES BUILDING

By H. A. Wheeler.

Important Exhibit in the Mines Building.

American Institute of Mining Engineers has its headquarters on Block 74, jointly with the United States Geological Survey.

Bethlehem Steel Company, on Block 22, shows an interesting series of modern guns, armor plate, turrets, and the special ingots from which gun tubes are made.

Pennsylvania State Commission, on Block 41, illustrates by models, anthracite coal mining through the mine and breaker to the market, also complete series of Pennsylvania mineral resources.

Tiffany Jewel Company, on Block 40, exhibits a very fine series of crude and cut gems and precious stones.

Clay Industry, on Block 20, present a very complete series of all kinds of clays and clay products, and is especially rich in refractory goods.

Alabama Commercial Club exhibits, on Block 72, a cast iron statue, 50 feet high, of Vulcan, weighing 50 tons.

Austin Co., on Block 73, exhibits a very complete line of rock crushing machinery.

Canada, on Block 54, has a very extensive series of ores and specimens illustrating the mineral resources of Canada.

Japan, on Block 44, exhibits a very complete series of mineral resources of the Japanese empire.

Colorado, on Block 71, has a fine series of rich gold ores and specimens, including the famous Campion series.

Montana, on Block 61, has a fine collection illustrating its copper resources.

Michigan, on Block 31, exhibits its copper and iron resources, including some copper masses.

Missouri, on Block 50, illustrates the lead and zinc resources of Missouri.

Utah, on Block 70, exhibits a dry operating concentrator, also the mineral resources of Utah.

Allis-Chalmers Company, on Block 82, exhibits mining and smelting machinery.

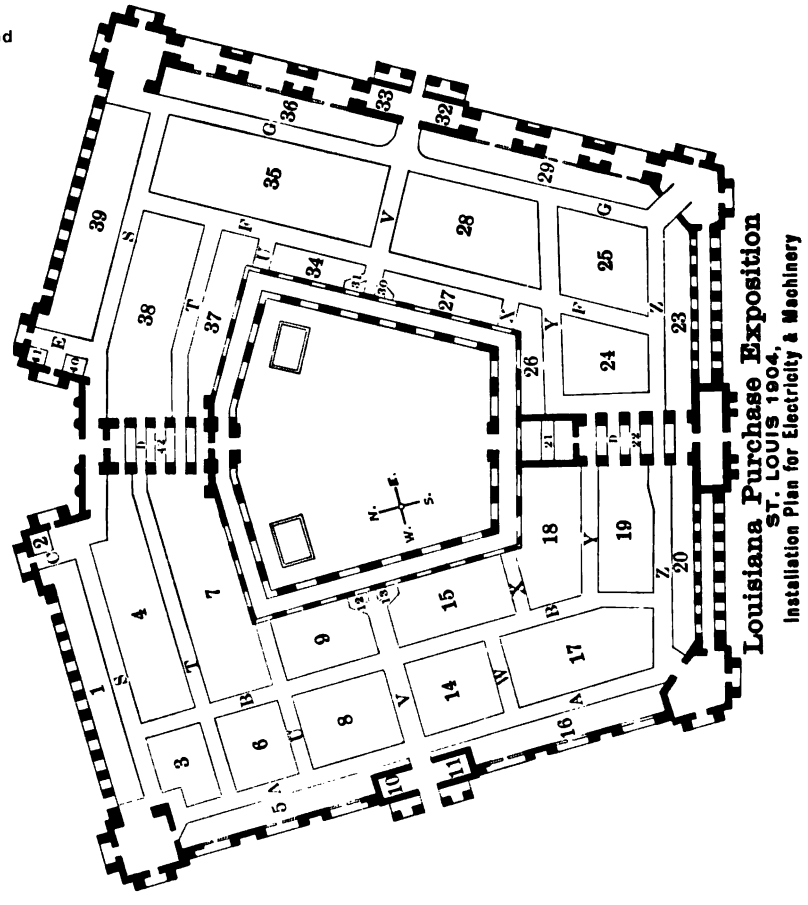
Standard Oil Co., on Block 43, shows a most interesting series of petroleums and petroleum products.

Internation Nickel Company exhibits, on Block 42, very interesting series of nickel ores and alloys.

In the 25 acres known as **"The Gulch," or Mining Reservation,** immediately southeast of the Mining Building, are a series of working exhibits as follows:

United States Portland Cement Ass'n has erected a concrete pavilion with which are exhibited a series of cement construction exhibits. (Opposite Fisheries Building.)

Installation Plan for Electricity and Machinery.



Important Exhibit in the Mines Building.

The Weller Pottery Company exhibits a complete working art pottery on Federal Ave.

Model Fuel Testing Plant, operated by the United States Geological Survey, illustrates the washing, coking and testing of coals in carload samples. The coals are being shipped from all the coal districts of this country.

Well Drilling and Prospecting; several of these outfits are in operation in this vicinity.

DeLaval Steam Turbine Company, at the rustic bridge on Federal Ave., exhibits deep mining and hydraulic turbines operated by steam and electric motors.

Worthington Pump Company exhibits deep mining centrifugal pumps in operation on the opposite side of the Federal Ave. Bridge.

Leschen & Sons exhibit a double wire rope tramway about one-fourth mile long.

South Dakota Commission exhibits the cyanide process of gold extraction in a mill adjoining the California mill.

California Commission exhibits a gold mill, crushing with stamps and roller mills, and saving the sulphurets by several different kinds of tables.

Missouri Commission illustrates the concentration of zinc ores with a Joplin mill and the smelting of lead by the early Missouri Scotch Hearth process.

Missouri Lead and Zinc Company reproduce a very interesting southwest Missouri lead and zinc mine.

Carrizo Copper Company, corner Federal and Colonial Aves., from Carrizo, State of Jalisco, Mexico, reproduces the Indian method of washing and smelting of copper ores and the working of the pig copper into ornamental copper vessels by hand.

An Arizona Mining Camp is reproduced on three acres on the south side of Colonial Ave.

ELECTRICITY BUILDING

By W. E. Goldsborough.

Exhibits of Special Interest in the Electricity Building.

Section 1. Gray National Telautograph Company's exhibit of apparatus for transmitting chirography—the Delany system of rapid telegraphy.

Section 3. Exhibit of the Baldwin Locomotive Works of locomotives. Exhibit of the Standard Underground Cable Company, showing duct and cable installations.

Section 4. Working exhibits of X-Ray apparatus.

Section 5. Exhibit by the Electric Controller & Supply Company of magnetic clutch reversing gear.

Section 6. Exhibit by the National Electric Company of electro-pneumatic multiple train controller system.

Exhibits of Special Interest in the Electricity Building.

Exhibit 7. Exhibit by the Westinghouse Electric & Mfg. Company of new single-phase railway motors and equipments. Exhibit by Great Britain of fine electrical instruments.

Section 9. Exhibit of the Wagner Electric Mfg. Company of single-phase motors.

Section 10. Exhibit by C. F. Hall of special electro-plating methods.

Section 12. Exhibit by Chas. E. Yetman of rapid telegraph apparatus.

Section 14. Exhibit by Northern Electrical Mfg. Company of special applications of electric motors. Exhibit by Pawling & Harnischfeger of electric crane and hoists. Exhibit by the Prometheus Electric Company of electric heating apparatus.

Section 15. Exhibit by the Bullock Electric Mfg. Company of special alternating current machinery.

Section 16. Exhibit by Gould Storage Battery Company of special high capacity cells; by Japanese exhibitors of electric machinery made in Japan.

Section 17. Exhibits by the Western Electric Company of special motor applications and alternating current arc lamp system. Exhibit by the American Telephone & Telegraph Company of transmission of speech by light rays.

Section 18. Exhibit by Italy of fine instruments.

Section 19. Exhibit by DeForest Wireless Telegraph Company of a transmitting and receiving station of wireless telegraph system.

Section 20. Exhibit by the American Electric Heater Company of electric heating apparatus. By the Electric Storage Battery Company of special storage battery house and installation.

Section 22. Exhibit by J. Van Inwagen of an electric clock.

Section 23. Exhibit by Hutchison Acoustic Company of special apparatus for treatment of the deaf. Exhibit by the Collins Wireless Telephone Company of wireless telephone apparatus.

Section 24. Exhibit by the Automatic Telephone Company of automatic telephone apparatus.

Section 25. Exhibit by the Weston Electrical Instrument Company of fine instruments. Exhibit by the Purdue Research Laboratory of special photometric apparatus; by the Holophane Glass Company of special globes.

Section 26. Exhibit by the Association of Edison Illuminating Companies of Edison historic apparatus.

Section 27. Exhibit by Edison Storage Battery Company of Edison batteries.

Section 28. Exhibit by the General Electric Company of fine instruments and special motor applications.

Section 29. Exhibit by the Bureau of Standards of an electrical laboratory.

Section 35. Exhibit by the German Government of electrochemistry.

Section 38. Exhibit by France of fine instruments, historic apparatus and high-art electroliers.

Electrical Exhibits Outside of the Electricity Building.

Exhibit by the DeForest Wireless Telegraph Company of wireless telegraph transmission stations in the Model City and on the hill south of Machinery Hall.

Exhibit by the German Government of electric railway signaling system north of Forestry, Fish and Game Building.

Exhibit of outdoor electric railway equipments on the experimental track north of the Transportation Building.

EDUCATION BUILDING.

Exhibit by Germany of fine electrical instruments.

MACHINERY BUILDING.

Exhibit by the Bullock Electric Mfg. Co. of 3500 K.W. generator and accessories.

Exhibit by the General Electric Co. of 2000 K.W. turbo generator.

Exhibit by the Westinghouse Electric & Mfg. Co. of a turbo generator and accessories.

TRANSPORTATION BUILDING

By H. A. Wheeler.

Important Exhibits in the Transportation Building.

Pennsylvania Railroad Company, in the west part of the building, has a very complete plant, costing about $500,000, for testing American and European locomotives during the Exposition. The **New York Improvements,** including the terminal station and the tunnels under the North and East rivers, which are expected to cost about $50,000,000, are shown by models and charts.

The Baltimore & Ohio Railroad Company, in the east end of the building, exhibits a series of locomotives and models illustrating the history and development of transportation from the "Hero" engine to a 200-ton locomotive. The developement of roadbeds is also shown under these locomotives. This exhibit cost about $100,000.

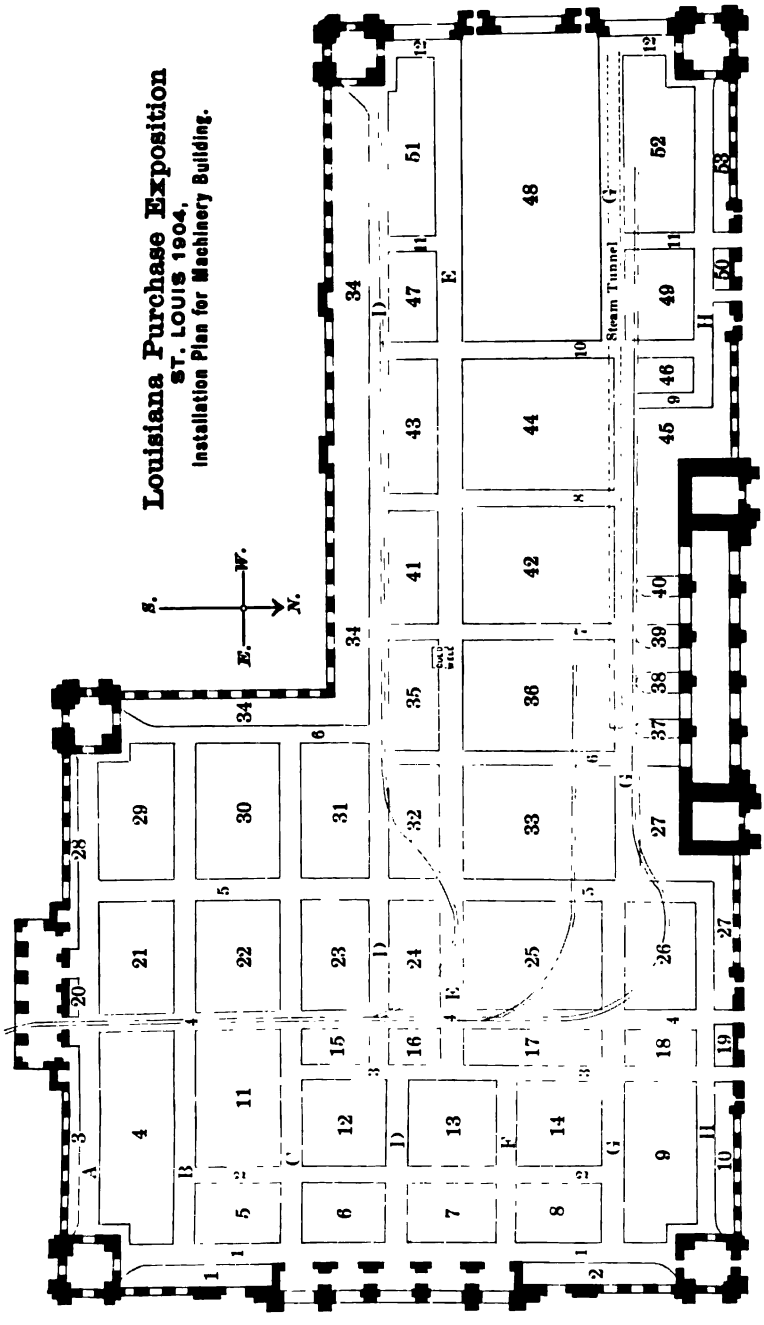
The Pullman Car Company, in the central part of the building exhibits two model trains of the latest designs.

The New York Central Railroad, in the central part of the building, exhibits its famous "Empire State Express."

The Baldwin Locomotive Works, in the western part of the building, shows some of its latest designs in locomotive construction.

The American and Roger Locomotive Works also make neighboring exhibits.

Installation Plan for Machinery Building.



Important Exhibits in the Transportation Building.

The Automobile section is in the northeast portion of the building.

The Motor Boat section is in the southeast portion of the building.

The Marine section is in the southwest portion of the building.

The Aeronautic course and **Balloon Barn** are on the plateau west of the Administration Building, adjoining Station No. 4 of the Intramural Railway.

MACHINERY HALL

By J. M. Chaphe.

Exhibits of Special Interest in Machinery Hall.

The Westinghouse Engine Company exhibits four vertical compound engines of 3200 h.p. each that are direct-connected to 2000 k.w. generators. They also exhibit a 300 h.p. steam turbine and a 300 h.p. gas engine.

The Allis-Chalmers Company exhibits a combined horizontal and vertical 5000 h.p. compound engine direct connected to a 3500 k.w. Bullock generator.

The Mülhouse Engine Company (of Germany), exhibits a tandem compound 1000 h.p. engine.

The Willans Engine Company exhibits a triple triplex 1000 h.p. engine.

The Buckeye Engine Company exhibits a cross-compound 1000 h.p. engine.

The Hamilton-Corliss Engine Company exhibits a vertical 2250 h.p. engine. They also exhibit a 1500 h.p. steam turbine.

The Brown-Corliss Engine Company exhibits an 800 h.p. and a 500 h.p. compound vertical engine.

The Intramural Railway service is furnished by four engines made by the **Murray Iron Works**, the **Harrisburg Engine Company**, the **Lane & Bodley Engine Company** and the **Greenwald Engine Company of 1000 h.p. each.**

The Otto Gas Engine Company exhibits several sizes of gas engines.

Fairbanks, Morse & Company exhibit several sizes of gas engines.

The General Electric Company exhibits several steam turbines.

The Niles-Bement Company exhibits a 20-foot swing boring-machine, besides a full series of machine tools.

All the above engines are located in the western part of Machinery Hall and receive their steam from a header carried in an underground conduit. They aggregate about 38,000 h.p.

Exhibits in Machinery Hall.

The Boiler House is immediately west of Machinery Hall and has the following equipment, aggregating about 40,000 h.p.:

Sixteen Babcock & Wilcox water-tube boilers, 450 h.p. each, equipped with Roney stokers and operated by induced draft obtained by the use of 14-foot fans.

Three Cahall water-tube boilers of 400 h.p. each.

Eight Heine water-tube boilers of 400 h.p. each, equipped with Green traveling grates.

The Aultman-Taylor Company has 16 B. & W. type water-tube boilers of 450 h.p. each, equipped with Playford chain grates.

The Heine & Cahall boilers are also provided with induced draft by a 14-foot fan.

The following boilers have natural draft and are hand fired:

Two Climax water tube boilers, one of 350 and one of 450 h.p.

Three DuLauney, Belville type, 500 h.p. boilers (from France).

One 500 h.p. Doehr water-tube boiler (from Germany).

Two Nicalaus boilers of 350 h.p. each made by the Stirling Boiler Company.

All the boilers have the coal supplied to and the ashes taken away by the Link Belt Machinery System of Conveyors.

In the Boiler House are 14 Worthington Underwriters' Fire Pumps of 1000 gallons capacity each, which are capable of supplying the entire grounds by special pipe system with water at 300 pounds pressure.

DIVISION II.

Engineering Guide

TO

St. Louis and Vicinity.

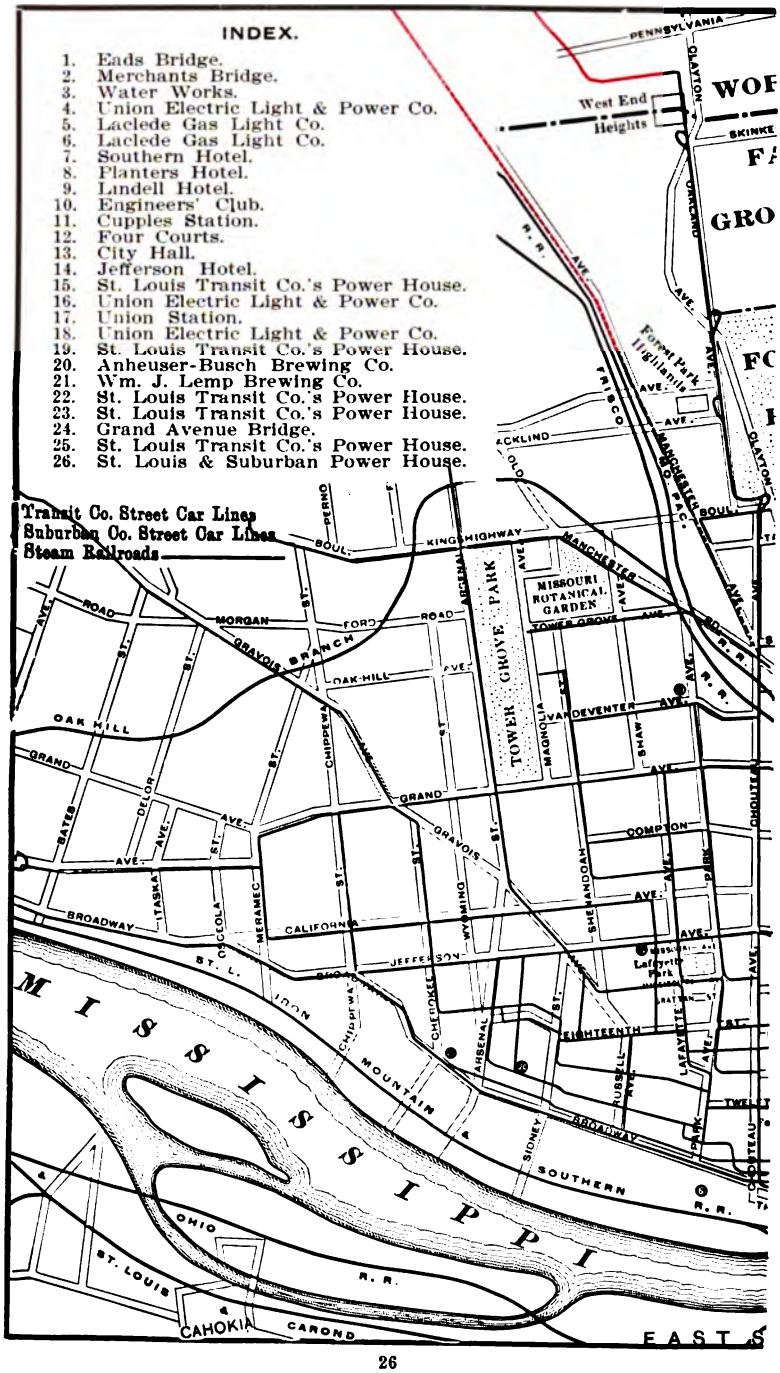
Committee:

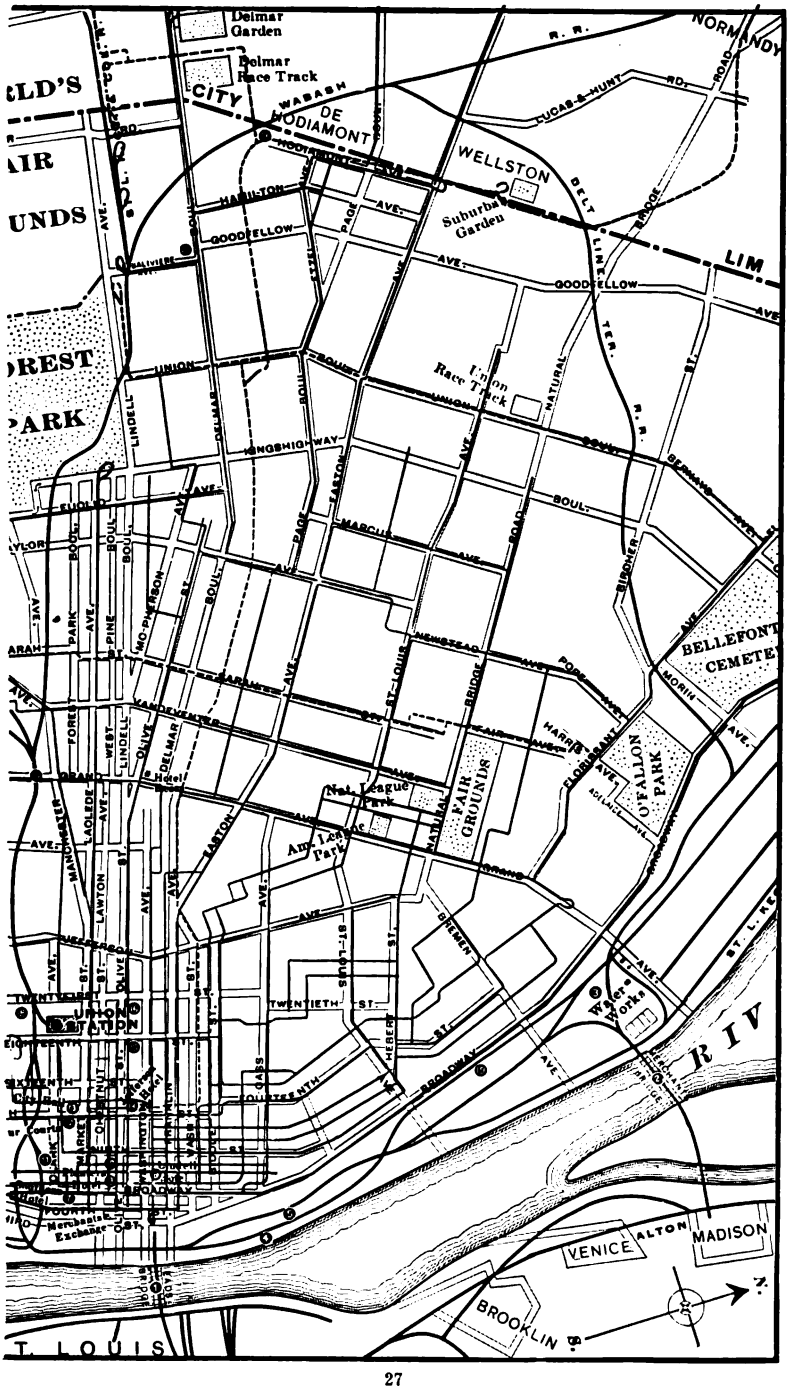
A. S. LANGSDORF, CHAIRMAN.

W. H. BRYAN.

H. A. WHEELER.

Map of the City of St. Louis.





Map of the City of St. Louis.

Civil Engineering

BRIDGES AND VIADUCTS

Eads Bridge, over the Mississippi River at the foot of Washington Ave.

THE Eads Bridge, designed and built by Captain James B. Eads, 1868 to 1875, is a double-deck steel arch bridge, carrying two railroad tracks on the lower, and a driveway, two sidewalks and two street railway tracks on the upper roadway. The river spans are composed of two side spans of 502 feet, and a center span of 520 feet in the clear, with a rise of 47 feet, the lower roadway being 90 feet above low water. Each span is composed of four rigid double steel arches, each arch consisting of two ribs, or chords, spaced twelve feet apart by interior triangular trussed bracing. These arches are continuous at the crown and are rigidly fixed to the abutments and piers. The ribs are hollow cylinders in sections twelve feet long and are composed of six staves of hard chrome steel enclosed in a shrunken steel casing. These sections are connected by grooved steel "couplings" to which are attached the bracing and framework of the bridge. The bridge rests on pneumatic caissons varying in depth from 60 to 90 feet from low water to solid rock. The railroad apprcach on the west is through a tunnel, 5232 feet long, under the city. The east approach is a steel viaduct 2120 feet long.

Total cost of bridge, $6,500,000.

St. Louis Merchants' Bridge, over the Mississippi River at the foot of Grand Ave.

The three main spans of this bridge are through, pin-connected, Petit trusses, 517 feet 6 inches long, carrying a double track railway. The two trusses are 30 feet apart and are 75 feet deep at the center. The top chords are curved and the vertical posts form panel lengths of 28 feet 8¾ inches. The deck is 90 feet above low water. The four main piers were carried by pneumatic caissons to bedrock, about forty feet below low water. Three spans of 125 feet each adjoin the bridge on each side, which connect by steel viaducts to the dirt embankments.

Built in 1889-90 (14 months). E. L. Corthell, M. Am. Soc. C. E., Chief Engineer; Geo. S. Morison, M. Am. Soc. C. E., Consulting Engineer.

Bellefontaine Bridge.

The Bellefontaine bridge consists of four main double-track spans of 440 feet each. There is a steel viaduct approach on the north 850 feet long and 48 feet high. Three of the four river

piers rest on pneumatic caissons carried to bed-rock at depths of 68, 89 and 110 feet below low water, respectively; the fourth pier rests in sand at 83 feet below low water. The piers are of Bedford limestone with face stones of granite. The bents of the viaduct approach are supported on brick cylinder piers resting on piles surmounted by a timber grillage.

The four river spans are of the Pratt type, with parallel chords and single system webs, with no adjustable members. Both top and bottom lateral systems are riveted.

The trusses and stringers are designed for moving loads of 3000 and 7700 pounds per foot of track, respectively; the floor beams are designed for 5775 pounds per foot of track.

Total cost of bridge, $1,322,720.

Geo. S. Morison, M. Am. Soc. C. E., Chief Engineer.

The Bellefontaine Bridge of the Chicago, Burlington & Quincy Railway over the Missouri River, Twenty Miles North of St. Louis.

This bridge is now being constructed for the use of the Iron Mountain, Cotton Belt, and Frisco roads on the west, and the Illinois Central, Chicago & Eastern Illinois, and Iron Mountain roads on the east, which at present transfer by car ferries.

There will be five river spans. The central, or channel span, will be 671 feet long, made up of a suspended span of 366 feet and two cantilever arms of 152½ feet each. Next, on either side, will be two fixed spans of 521 feet 2 inches each. Then will follow the two shore spans of 518½ feet each, made up of a suspended span of 366 feet and a cantilever arm of 152½ feet.

The trusses will be 32 feet between centers and 28 feet in the clear. Their heights, from center to center of chords, will be 75 feet for the fixed spans, 55 feet for the suspended spans, and 50 feet for the cantilever arms. The panel lengths for the fixed spans will be 32 feet 6⅞ inches, and 30 feet 6 inches for the suspended spans and cantilever arms. Height of bottom chord above low water, 103 feet; above high water, 65 feet.

The approaches will consist of semi-circular concrete arches, of which there will be five on the east and seven on the west side. They will have spans of 65 feet each, except one on the west of 100 feet span.

Five of the six piers rest on pneumatic caissons carried to bed rock; the foundations of the sixth pier, on the Missouri shore, is in open excavation. The face stones of the piers will be of Bedford limestone, except the cut-water stones, which, below high water, will be of granite. The backing is to be of Portland cement concrete.

The floor system is designed for a moving load of 5000 pounds per foot of track plus 50,000 pounds concentrated. On the trusses this assumed load was reduced 20 per cent. The wind pressure was taken at 1000 pounds per foot of bridge.

Alfred Noble, Past President Am. Soc. C. E., and Ralph Modjeski, M. Am. Soc. C. E., Engineers.

Total estimated cost of the bridge, $2,600,000.

The Thebes Bridge over the Mississippi River near Thebes, Illinois, 143 miles (by river) below St. Louis.

EADS BRIDGE.

Among the numerous viaducts crossing the railroad tracks in the city, the Grand Avenue Bridge, which was completed in 1889, deserves mention on account of its magnitude and architectural effect. It is a stiffened suspension bridge, designed on the principle of an inverted hinged arch, with a middle span of 400 feet in length. Width of roadway, 36 feet; width of each sidewalk, 12 feet. The total length of the bridge is 1600 feet, and its cost was $430,000.

Carl Gayler, C. E., Chief Engineer.

Grand Avenue Bridge over the Mill Creek Valley.

This is a double-track arch on the line of the Iron Mountain R. R. It is built of Portland cement concrete without steel re-enforcement, has a span of 100 feet in the clear, and is four feet thick at the crown.

Concrete Arch over the River Des Peres at Carondelet.

TERMINAL RAILROAD ASSOCIATION OF ST. LOUIS

This is a double-track steel viaduct running from Biddle Street along the levee and around to the railroad yard at 12th Street. It is 10,600 feet long, averaging 30 feet spans, 24 feet high and 18 feet 6 inches wide.

Elevated Railway Viaduct.

The construction consists of four plate-girder stringers riveted to crossbeams, and two vertical columns of "H" form anchored to concrete footings.

Built in 1891-92. Robt. Moore, M. Am. Soc. C. E., Chief Engineer.

These general repair shops are just north of East St. Louis and cover a twenty-acre triangular tract. These shops are entirely new and strictly modern, and are designed to keep in repair the 100 switching engines and cars of the company.

Terminal Railroad Repair Shops.

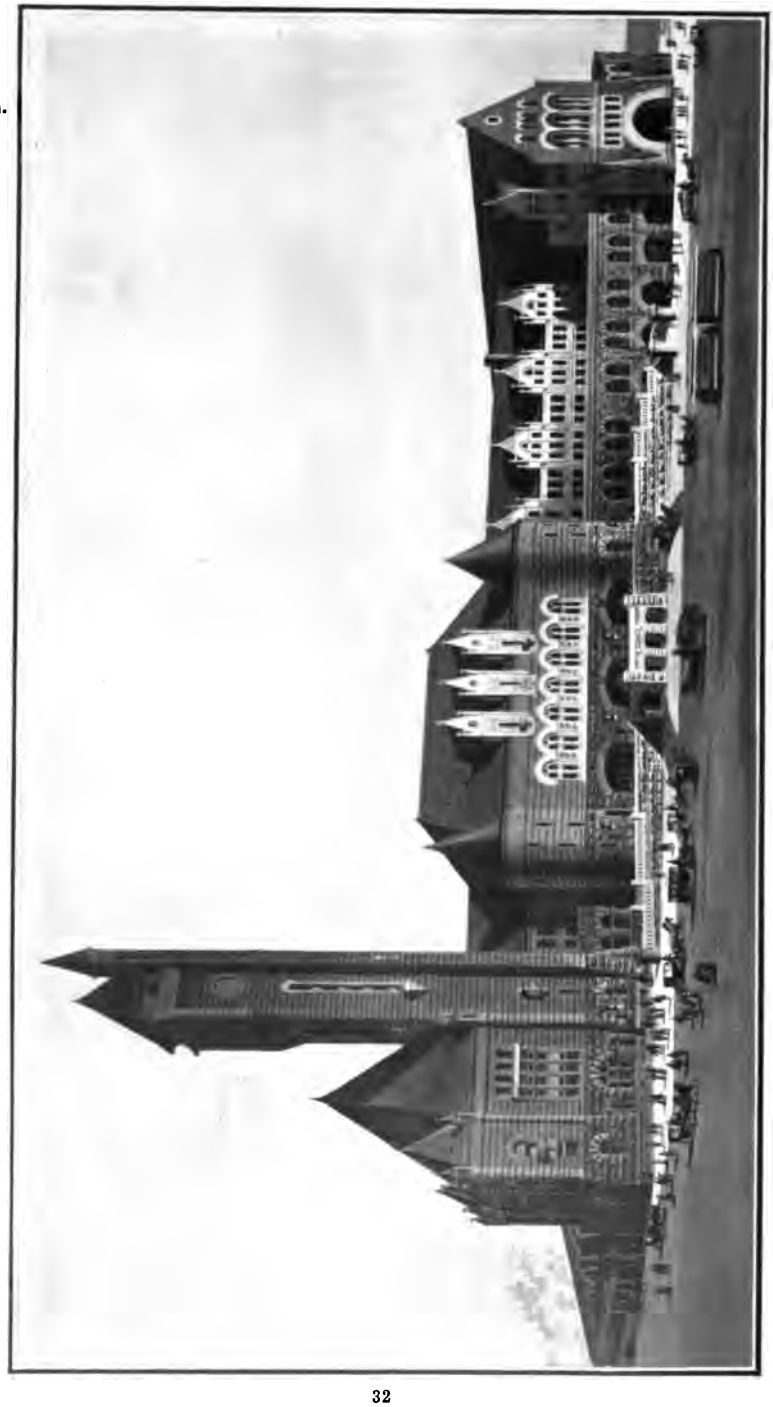
An 80-foot roundhouse of 16 stalls is equipped with cleaning and wheel pits, and is reached by a 70-foot electric turntable.

A 150-ton, 70-foot electric transfer table on a pit 304 feet long divides the machine, boiler, and blacksmith shop from the wood and paint shop. The machine erecting shop, 250 feet by 123 feet, has its 10 track pits served by an 80-ton 62-foot electric crane. The machine shop tools are all electrically driven.

The blacksmith shop, 75 feet by 123 feet, is equipped with down-draft forges, a 1500-pound steam hammer, shears, etc.

The wood and paint shop, 110 feet by 100 feet, is arranged for coach and engine work. A power house, 92 feet by 98 feet, contains four 250 h.p. boilers, automatically stoked, three 175 h.p. engines, one 350 h.p. air compressor, three 125 k.w. generators, and a 10-ton 42-foot hand crane.

St. Louis
Union Station.



UNION STATION.

All buildings are brick, composition roofed, are electrically lighted and hot-air heated, and are connected by concrete conduits carrying wires and pipes.

Union Station Terminal Facilities.

The Union Station on Market St., between 18th and 20th Sts., is used by all trunk line passenger trains entering St. Louis. Trains approach from the east over the Eads Bridge or the Merchants' Elevated, and from the west from Grand Avenue, but all back into the station towards the north. The approach tracks consist of six mains, divided into two throats of three tracks, each throat connecting with sixteen tracks under the train shed. Lead tracks connect the station with coach storage and head end yards, which are specially equipped for economic car service. The station serves 19 railroads handling 278 daily trains and 400,000 coaches annually.

Opened for service September 1, 1894.

Train Shed.

The train shed covers an area of 601 by 880 feet, or 12.13 acres, of which 601 by 120 feet is midway. The 32 tracks, each from 900 to 1000 feet long, give clear standing room of 25,600 feet. The steel shed is a single elliptical curve 601 feet long and 75 feet high in the center. The symmetrical center span is 141.30 feet long, and the side spans are 139.18 feet and 90.67 feet, respectively. It is lighted by glass ends, and by one central and thirteen lateral clere stories with glass sides and ventilating louvres. The trusses are 30 feet apart, with inside columns 60 feet center to center.

Designed by Geo. H. Pegram, M. Am. Soc. C. E., 1893.

System of Subways.

A system of subways extend under the tracks for the rapid and economic handling of baggage, mail and express. The system covers 161,700 square feet, and consists of a main subway 120 feet wide by 601 feet, and branch subways to the headhouse, express, mail and baggage buildings, and to the power house. The main subway, built at the south end of the train shed and crossed by 32 tracks, is accessible by wagons from below and is equipped with 35 hydraulic elevators rising 22 feet to the level of the floors of cars. It is served by pneumatic tubes from the headhouse and baggage room, which carry baggage checks to the subway, where all baggage is weighed and handled. Steel plate girders support the overhead tracks, and all walls are concrete. The asphalt floors are well drained, and all subways are electrically lighted.

Express, Mail and Baggage Buildings.

To handle the large quantities of express, mail and baggage transferred and originating at this station, large buildings specially designed are located south of the train shed. A solid block of five express buildings, 838 feet long, with two stories and basement, furnishes 161,400 feet of floor space. A three-story mail building with basement has 34,400 square feet of space, and

a two-story baggage building has 17,800 square feet. All buildings are of heavy warehouse construction, with brick walls on concrete foundations, are slate covered and are connected to subway.

Power House.

A power house, 99 feet by 146 feet, generating 2750 h.p., supplies the heat and power. It is a fire-proof building with a 200-foot stack and a 15-ton 42-foot crane. The equipment consists of ten 275 h.p. boilers with mechanical stokers and automatic coal delivery, four 350 k.w., two-phase direct-connected generators, two 200 k.w. rotary converters, two 62 k.w. exciters, two 257 h.p. air compressors and three 12 by 5 by 18-inch hydraulic pumps, with necessary complement of feed water heaters, pumps, etc.

Interlocking Plant.

This is the largest interlocking plant in the world. It controls the 1835 daily train movements at Union Station. It is an electro-pneumatic system installed in three towers with a total of 321 levers, 261 of which operate 90 switches, 67 double slips and 284 signals. There are 215 levers in the largest machine. Air and electricity are furnished from the power house. There are 2048 lineal feet of signal bridging.

Engine Houses and Coaling Plant.

Engines from the Union Station are coaled, cleaned, watered, and sanded at a 1000-ton coaling plant at 16th Street. Fifteen engines can clean at one time, seven of which can be coaling and watering simultaneously. Coal, sand and ash handling are entirely automatic. The structure is of steel throughout and is built on concrete foundations.

Three brick engine houses are adjacent to the coaling plant and accommodate 61 engines. The houses are rectangular and are served by four 75-foot electric transfer tables on two pits, 170 and 195 feet long, respectively.

Summary.

All of the above properties, together with freight yards and main line tracks, constitute a large terminal unit controlled by the Terminal Railroad Association. The recent improvements in facilities, including an extension of the train shed of 180 feet, were built in 1903-1904.

Daniel Breck, Chief Engineer.

MUNICIPAL IMPROVEMENTS

The St. Louis Water Works.

The water supply for the City of St. Louis is taken from the Mississippi River at the Chain of Rocks, about eleven miles above the Eads Bridge. The supply is drawn through a tunnel driven in the limestone bed rock under the river and ending at an inlet tower about 1500 feet from the Missouri shore. This tower is built of granite masonry, and is provided with gates

operated by hydraulic machinery, screens and gate house. The tunnel is seven feet inside diameter and approximately 2136 feet long, and connects the inlet tower with a screen chamber near the engine house. The tunnel will deliver 100 million gallons every twenty-four hours at a velocity of four feet per second. The engine pits at the low service station are three in number, each fifty feet square by fifty feet deep. There are six compound low-service engines at this station, four of which have a capacity of thirty million gallons each per twenty-four hours, and two of twenty million gallons each per twenty-four hours, making a total of 160 millions per twenty-four hours.

The water is delivered from this station through a masonry conduit to a series of six settling basins, each of which is 670 feet by 400 feet, with a working depth varying from 13 feet to 9½ feet. These basins are operated on the continuous sedimentation plan, the water entering No. 1 and flowing over weirs 610 feet long from each basin to the next, the whole supply being drawn from the sixth and last basin. The capacity of the basins is about 170,000,000 gallons, the quantity varying somewhat with the amount of water pumped.

The water is delivered from the sixth basin through an eleven-foot masonry conduit, about three and one-half miles long, to the Baden High-Service Station, thence is reduced to a nine-foot conduit to the Bissell's Point High-Service Station.

The Baden High-Service Station consists of Engine House No. 3, containing six triple-expansion, high-service pumping engines with a total daily capacity of eighty million gallons; boiler house, machine shop, generator house, blacksmith shop, store house, office, etc. The engines deliver water at a pressure of 125 pounds.

The Bissell's Point High-Service Station comprises two engine houses, boiler houses, storage coal shed, machine shop, offices, etc. In Bissell's Point Engine House No. 1 are two triple-expansion Allis-Chalmers pumps, with a capacity of twenty million gallons each per twenty-four hours. A third engine of the same capacity is being installed in this house and will be in service by the end of this year. In Bissell's Point Engine House No. 2 there are three single-cylinder beam engines, with a total capacity of fifty million gallons per day. Engines at Bissell's Point pump to two towers at the top of the hill above the station, while the Baden station pumps to an overflow tower at Compton Hill reservoir. This reservoir is about 500 by 800 feet and 22 feet deep, with capacity of 60,000,000 gallons. The reservoir is divided into two equal basins by a middle wall.

The two High-Service Stations and the Low-Service Station at the Chain of Rocks are connected by the Water Works Rail-

Expenditures and Revenues of St. Louis Water Works, 1884 to 1904.

EXPENDITURES AND REVENUES OF ST. LOUIS WATER WORKS, 1884 TO 1904.

Year ending in	Expended for Operating and Maintaining Works.	Expended for Laying Water Pipe.	Expended for Extension of Pumping Works.	Number of U. S. Gallons of Water Pumped into the City.	Revenues.	Miles of Water Pipes in Service.	Number of Fire Plugs in Service.	Number of Taps in Service.	Number of Meters in Service.
1884	$259,173.41	$ 66,159.84	$175,545.00	9,542,471,000	$ 736,694.26	238	2,168	25,321	1,522
1885	254,018.69	261,437.86	10,291.29	9,412,291,000	759,265.53	257	2,459	27,357	1,811
1886	233,800.68	232,446.54	81,221.14	9,817,943,000	800,325.70	279	2,685	29,884	2,143
1887	232,394.23	164,628.50	76,317.85	10,877,896,000	868,043.35	295	2,922	31,794	2,376
1888	258,700.29	141,600.04	91,867.45	11,520,608,000	919,975.18	314	3,161	34,022	2,662
1889	267,955.89	209,246.22	176,457.25	11,481,771,000	952,689.25	336	3,366	36,082	2,888
1890	251,258.41	104,595.64	235,422.07	11,863,457,000	1,017,016.20	354	3,515	38,183	3,115
1891	262,185.85	70,782.41	454,946.13	13,144,565,000	1,132,088.40	373	3,715	41,331	3,399
1892	316,229.74	149,202.64	830,335.94	14,453,390,000	1,173,998.30	393	3,916	44,382	3,601
1893	349,978.34	125,986.62	.....	16,140,476,000	1,253,933.30	410	4,103	47,445	3,750
1894	385,104.67	196,019.70	.....	17,366,270,000	1,250,935.25	447	4,504	50,540	3,850
1895	436,167.52	147,815.40	.....	20,030,271,000	1,264,253.60	462	4,690	53,354	3,979
1896	416,103.26	391,400.99	.....	19,542,768,000	1,310,412.45	493	5,020	56,865	4,092
1897	438,758.50	272,204.94	.....	18,653,013,000	1,335,635.20	532	5,447	59,423	4,198
1898	443,631.94	218,675.64	.....	20,366,176,000	1,383,564.45	555	5,723	61,839	4,151
1899	463,052.13	273,214.80	.....	20,800,292,000	1,379,361.40	581	6,325	63,851	4,161
1900	493,179.56	319,118.54	.....	22,114,261,000	1,482,053.80	616	6,920	65,688	4,133
1901	534,594.68	463,336.19	.....	22,993,668,000	1,607,168.82	638	7,325	67,243	4,331
1902	547,221.53	265,436.63	.....	24,525,121,000	1,725,140.90	669	7,676	69,483	4,525
1903	.....	.....	.....	.....	1,770,242.56	.....	.....	.....	.....
1904	.....	.....	.....	.....	.....	.....	.....	.....	.....

way, on which are operated two electric pasenger cars for employes, and a locomotive for switching purposes.

The distribution system supplying the city contains about 700 miles of pipe of various sizes from 48-inch to 6-inch. There are in use about 7800 F. P.'s and 4800 meters.

Sewer System.

The sewers in the city are all constructed and repaired by contract under the supervision of the Sewer Commissioner, a member of the Board of Public Improvements, and are divided into four classes for the purpose of assessing the cost of construction:

"Public" sewers are those recommended by the Board of Public Improvements to be constructed without creating a sewer "district" or "joint district," and are provided for by ordinance and paid for out of the general revenue.

"District" sewers are constructed within the limits of an established sewer district or natural water-shed, and are paid for by special tax assessed upon the property in the district.

"Joint District" sewers are sewers connecting two or more districts or natural water-sheds, and are paid for by special tax assessed on the property in the said "district" or "joint district."

"Private" sewers are built and paid for by private owners in portions of the city where there are no city sewers.

The maintenance of all sewers, excepting private ones, is paid for wholly out of the general revenue.

All the main sewers empty into the Mississippi River, and pumping is not resorted to, save in one instance where the sewage from the World's Fair grounds is pumped through a 24-inch steel pipe into the Pine Street sewer.

The following is a tabulated statement of the sizes, kinds and lengths of sewers:

Stone and Brick Sewers.		
12½′x15′, 16′x20′, and larger	5.657	miles.
9′ to 13′ diameter (mean)	8.090	"
Brick Sewers.		
6′ to 9′ diameter (mean)	22.703	"
4′ to 5½′ diameter (mean)	30.410	"
1½′ to 3½′ diameter (mean)	187.988	"
Clay Pipe Sewers.		
2¼′ to 3′ diameter	3.028	"
½′ to 2′ diameter	296.645	"
Cement Pipe Sewers.		
1′ to 2′ diameter	7.534	"
Total length of all public, district and joint district sewers	562.055	"

The total cost to date of all public, district and joint district sewers, including the cost of engineering and maintenance, is $13,413,052.80.

Streets and Alleys.

The care of the streets of the City of St. Louis is in the hands of the Street Commissioner, a member of the Board of Public Improvements, who is appointed by the Mayor for a term of four years.

There are 881 miles of street in the city, divided as follows:

Unimproved		413 miles.
Improved—		
Paved with macadam	233.7	
" " telford	78.5	
" " novaculite	8.7	
" " asphalt	28.3	
" " bituminous macadam	6.3	
" " granite	57.3	
" " vitrified brick	51.9	
" " wood blocks	3.3	
		468 miles.
Total		881 "

In addition there are 124 miles of paved alleys.

Street improvement and reconstruction work is done by contract and the total cost thereof is assessed as a special tax, one-fourth against the abutting property on a front foot basis and three-fourths against a district defined by the city charter on an area basis. In general, this district includes all of the property on each side of the street to be improved up to a line midway between said street and the next parallel or converging street. The contractor is paid in special tax bills, which he must collect from the property owners.

No more macadam, telford or novaculite streets will be built by the city.

During the year there were built:

11.80	miles asphalt streets.
6.20	" bituminous macadam streets.
3.05	" granite streets.
12.75	" vitrified brick streets.
1.47	" wood block streets.
35.27	" total.

In addition 5.33 miles of alley were built.

The year 1904 will in all probability show a greater mileage constructed. The standard form of construction at present for all streets consists of a six-inch granite curb and a concrete foundation upon which the paving material is laid.

Asphalt pavement consists of a binder course 1½ inches thick when rolled, composed of clean broken stone not exceeding 1½ inches, thoroughly mixed hot with asphaltic cement in the proportion by volume of about 25 parts of broken stone to one part of asphaltic cement. On top of this is laid a wearing surface one and one-half inches thick after compression, containing the following ingredients which are mixed hot:

Asphalt cement	12% to 15%
Sand	83% to 70%
Pulverized carbonate of lime	5% to 15%

The approximate cost of this pavement, including an average amount of curbing and grading, is $33.00 per square. The wearing surface has a life of from five to seven years. The contracts include a ten-year maintenance clause. Asphalt pavements have been laid in St. Louis for twenty years.

Bituminous macadam pavement has a wearing surface two inches thick after rolling, composed of crushed granite or porphyry, ranging in size from two inches to an impalpable powder, mixed with sand, and containing all sizes so that the mineral aggregate shall contain the least possible amount of voids. This stone is heated and with it is mixed about 10 per cent of hot bituminous pitch. Upon this surface is spread a thin coating of quick-drying bitumen, after which a thin layer of small granite or porphyry chips is rolled into the surface. By varying the size of these chips any desired degree of roughness can be obtained. The approximate cost of this pavement, including grading and curbing, is $35.00 per square. As the first pavement of this kind was laid in St. Louis in 1903, no statement as to its life can be given. It has, however, proved to be very satisfactory so far and gives indications of a long life. The contract includes a six-year maintenance clause.

Granite pavement consists of granite blocks six inches deep laid on sand. Its cost varies between $30 and $40 per square. Some granite streets have been down twenty-five years and are still in good condition.

Vitrified brick pavements have been laid in St. Louis for the past ten years, and the first pavements laid are still in good condition. Judging from their appearance they seem good for another ten years. They are laid on sand and the joints between the bricks are filled with cement grout. The cost of vitrified brick pavement with all accessories as noted above is about $25.00 per square. The contract includes a six-year maintenance clause.

Wood block pavements of various kinds have been laid in St. Louis for a great many years, but have not proven satisfactory on account of their short life. At present a creosoted wooden block is used to a small extent, and it is claimed that it will have a life equal to vitrified brick. The cost of this pavement with accessories is $42.00 per 100 square feet. The contract includes a six-year maintenance clause.

The city makes all repairs on improved and unimproved streets with its own forces, except on asphalt streets which are repaired under a maintenance contract. It also does its own cleaning and washing of paved streets. During the year 1903 the following sums were appropriated for these purposes:

Street repairs	$268,014.00
Street cleaning	538,045.00
Total	$806,059.00

Street Sprinkling.

The improved streets are sprinkled by contract, the city being divided into 54 districts for this purpose. The contracts run from February 1st to February 1st of each year, and stipulate that sprinkling must be done whenever necessary. The city pays the sprinkling bills but is reimbursed by a special tax collected from the property owners. This tax amounts to about four or five cents per front foot per annum. About 510 miles of street are sprinkled. About 173 miles of street have street railway tracks on them. By the terms of their franchises the street railway companies construct and maintain that portion of the streets between their tracks, between the rails, and one foot outside of the rails, with a material equal to or better than that of the rest of the street.

City Lighting.

Street and alley lighting in this city is done by contract, electricity, gas and naphtha being used as illuminants. The total number of miles of streets lighted is 672.

Arc lighting, the contract for which is held by the Seckner Contracting Company, is confined to that part of the city east of Jefferson Avenue. There are 1000 arc lamps of the direct-current, series enclosed type, which are rated at 480 watts each. There are from 80 to 106 lamps to each circuit, the average voltage per circuit being 6600 volts. Current is supplied from the Tenth and St. Charles Street plant of the Union Electric Light & Power Co. The contract price is $23.77 per thousand hours.

Incandescent lighting, furnished by the same companies, is supplied by 800 30-candle-power lamps, at a cost of $4.79 per thousand hours.

Gas lighting is furnished by 14,000 mantle lamps at $6.81 per thousand hours, 250 Welsbach lamps at $11.00 per thousand hours, and 1400 gas lamps at $37.00 per lamp per year. The contract for this work is held by the Welsbach Incandescent Lamp Co., the gas being supplied by the Laclede Gas Light Co. In certain districts not piped for gas, naphtha is used.

The public buildings, including the City Hall, the new City Hospital, the Insane Asylum, Poor House, and Female Hospital, are lighted from separate power plants owned by the city.

RIVER IMPROVEMENT WORK

St. Louis being the metropolis of the Mississippi Valley may well be considered the headquarters for information concerning all improvements on the rivers of the Mississippi River system.

In this city will be found the headquarters of the Mississippi River Commission, in charge of improvements from the mouth of the Ohio River to the Head of Passes, near the

Gulf of Mexico, and of surveys, topographical, hydrographical and hydrometrical, of the river from its head waters to the Gulf of Mexico.

The U. S. Engineer Corps have charge of improvements between the headwaters and the mouth of the Ohio River and of the Snag Boat Service from St. Louis to Natchez.

Headwaters to Minneapolis, 350 miles. Headquarters at St. Paul, Minn.

Work consists of extensive reservoirs at the headwaters of the Mississippi River designed to store up the surplus water during the rainy season, to be let out in aid of navigation during low water. An extensive lock and dam is also under construction between St. Paul and Minneapolis to enable boats to reach the foot of the Falls of St. Anthony.

Minneapolis, Minn., to Mouth of Missouri River. Headquarters at Rock Island, Ill.

Revetment and contraction work for the improvement of navigation is carried on at many different points, the object being to secure a navigable channel six feet in depth.

The Des Moines Rapids Canal, at Keokuk, Iowa, is eight miles long, with three locks, with total lift of 18 feet, also a dry dock. Distance from St. Louis by river is 202 miles. The excellence of the hydraulic lock gates deserves special attention.

Thirty-three bridges span the river between Minneapolis and the mouth of the Missouri River.

Mouth of the Missouri River to Mouth of Ohio River, 210 miles. Headquarters at Custom House, St. Louis, Mo.

Revetment and contraction work is carried on at various points in this reach.

A low-water channel depth of eight feet is maintained by hydraulic dredges.

A snag boat service from St. Louis to Natchez is maintained for the removal of snags and other obstructions.

Illinois River.

Examinations, surveys, plans and estimates are being made by direction of Congress for a navigable waterway fourteen feet in depth from Lake Michigan via the Chicago Drainage Canal, the Illinois and Mississippi Rivers to St. Louis. This project is in charge of a Board of Army Engineers and the Mississippi River Commission.

Mouth of Ohio River to Head of Passes, 1060 miles.

Improvement work under the direction of the Mississippi River Commission, with headquarters at Fullerton Building, 7th and Pine Streets, St. Louis.

Revetment and contraction work at many points in this reach. Levee work to protect land from overflow begins 160 miles below St. Louis at the head of the alluvial basin and continues down to near the Gulf of Mexico.

Eight hydraulic dredges of great capacity are used to maintain at low water a channel at least nine feet in depth and 250 feet wide.

A cantilever bridge spans the river at Memphis, Tenn. It has one span 790 feet long and two 620 feet spans. Height above

Mississippi
Dredge Boat.

MISSISSIPPI DREDGE BOAT.

high water is 70 feet. No bridges cross the river below this point.

Work at South Pass consists of parallel jetties from deep water in the river to deep water in the Gulf. The improved channel in South Pass has a depth of 28 feet and is about 600 feet in width.

Jetties at Mouth of Mississippi River. Headquarters at New Orleans, Louisiana.

The improvement of Southwest Pass to provide 35 feet in depth at low tide is now under way. Jetties over four miles long will be required, and when completed this will be one of the best harbor entrances in the world.

The improvement of this river is in charge of the U. S. Engineer Corps with headquarters at Sioux City, Iowa. The principal work going on at present consists of the revetment of the banks where the erosion or caving threatens important towns or other great interests. In past years dike and revetment works have been placed at Omaha, Kansas City, Jefferson City, and other points.

Missouri River.

A lock and dam has also been placed in the Osage River, near its junction with the Missouri River.

No regular line of steamers now navigate the Missouri River.

Twenty-six bridges of various kinds span the Missouri River between Fort Benton and its mouth.

GENERAL

St. Louis Portland Cement Company. Works and clay beds at Prospect Hill, just north of the city limits; take C. B. & Q. R. R. Quarry and crusher pant at Ft. Bellefontaine, eight miles farther north.

Cement Works.

The plant was erected in 1902 and is modern throughout. Its present capacity is 1500 barrels per day but it is being enlarged to a capacity of 2800 barrels per day.

Equipment.—Power House:

6 Heine, safety water-tube boilers.

2 22 and 44 by 48-inch cross-compound condensing engines, driving line shafts.

2 400 h.p., tandem compound engines, each direct-connected to a 200 k.w. direct-current generator.

Air pumps and circulating pumps of condenser plant are motor driven.

Cement Handling Plant.—Drier Room:

4 54-inch by 50-foot rotary driers, two for stone, two for clay; rope driven.

Complete equipment of weighing hoppers.

Raw mill:

3 No. 66 comminuters (3 more to be installed).

4 Tube mills (2 more to be installed).

Kiln room:

8 6-foot by 60-foot rotary kilns, fired with powdered coal and each driven by a 15 h.p. motor.

2 Clinker crushers; set of comminuters and tube mills.

Stock house: Construction wholly of concrete and steel. Capacity 160,000 barrels.

The plant is wired on the three-wire system, 240 volts between outside wires, for convenience in lighting and motor speed regulation. The motor equipment totals about 550 h.p.

Neighboring Cement Plants.

Hannibal Plant of the Atlas Portland Cement Company. This plant is situated four miles south of Hannibal, Mo. (120 miles north of St. Louis on the C. B. & Q. R. R.), and is one of the largest cement plants in the world, with a daily capacity of 7000 barrels. It has 36 rotary kilns, uses local limestones and cements, and employs pulverized coal for fuel.

(No visitors admitted.)

Louisiana Portland Cement Mill. This plant is now in course of erection at Louisiana, Mo. (94 miles north of St. Louis on C. B. & Q. R. R.). It will have a daily capacity of 3000 barrels and will use local limestones and shales.

Iola Portland Cement Mill. This plant is situated in the Kansas gas belt at Iola, Kas. (367 miles from St. Louis via Mo. Pac. R. R.). It is a 21-kiln, or 3500-barrel plant. Local limestones and shale are used, that are worked by the slurry process and burned in rotary kilns by natural gas. Gas engines aggregating 2600 h.p. furnish the power. (No visitors admitted.)

Sand.

New Union Sand Company. Office, 211 N. Seventh St. This company operates a suction dredge scow in the Mississippi River. The boat carries two 14-inch centrifugal pumps with a capacity of 400 cubic yards per hour, that are direct-connected to Morris compound engines. The sand is washed and screened, then delivered on barges that are towed to the discharging wharves. Tyler Street wharf elevates the sand from the barges and delivers it into a bin with a Hoover & Mason 3½-yard "Grab." Capacity 100 cubic yards per hour. Take Broadway car north to Tyler Street, walk three blocks to river bank.

The East St. Louis wharf was built in 1903, has a steel frame and is equipped with a Hoover & Mason 5-yard "Grab," with a double 12 by 16-inch hoisting engine. Capacity 180 cubic yards per hour. Take Eads Bridge car at foot of Washington Avenue to east tower, thence by stairway to street and walk two blocks north.

Fatigue Tests on Cement.

This research work is being prosecuted for the purpose of developing the law of fatigue of concrete and other brittle engineering materials, both in compression and under transverse loads. The automatic apparatus and the general method pursued in these tests can be seen at the temporary Washington University Testing Laboratory, corner of Locust and Beaumont Streets.

Mining Engineering

ZINC MINES

Zinc Mines of Southwest Missouri.

THE Southwest Missouri or Joplin district is the largest producer of zinc in the United States, as the annual output ranges from 230,000 to 250,000 tons of zinc concentrates, valued at $7,000,000 to $8,000,000, from an area of about 30 by 60 miles. It also produces from 25,000 to 30,000 tons of lead concentrates annually, valued at about $1,500,000. The zinc is unusually pure, the concentrates assaying from 58% to 63%; the lead assays (wet) from 75% to 82%. The district, of which Joplin (population 25,000, Keystone Hotel) is the center, is about 300 miles southwest of St Louis, and is reached via the Frisco and Missouri Pacific railroads. In the immediate vicinity of Joplin are hundreds of mines and concentration mills, with an average capacity of 100 tons per shift. The entire district is worked on the leasing system. The mines are from 50 to 250 feet deep and the ore occurs as sheet deposits in horizontal beds of chert and as pockets of soft ore in cherty, sub-carboniferous limestones. At Chitwood Hollow, two miles west of Joplin, and at Webb City, six miles east of Joplin, are good types of these deposits. The mine run of ore ranges from 3% to 12% of zinc.

Zinc Smelters.

The mills are a special type based on the English system. The zinc concentrates are shipped to custom smelters located in the Kansas gas belt and the Illinois coal fields.

Glendale Zinc Works, at Carondelet (take Broadway car south) has 11 blocks of Belgian furnaces, with 2400 retorts. Roasting is performed by hand and by Brown mechanical roasters.

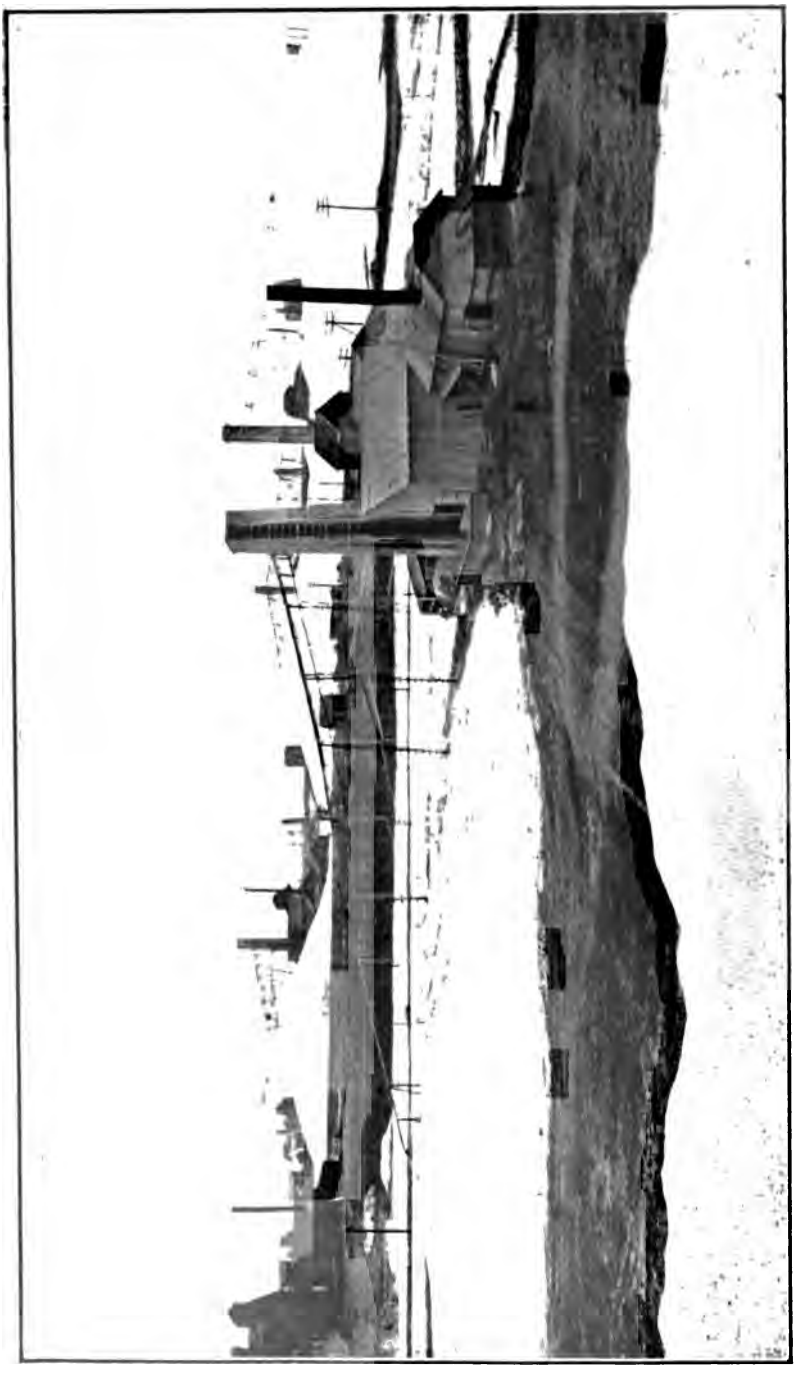
Collinsville Zinc Works, at Collinsville, Ill., 13 miles distant from St. Louis (via Vandalia R. R. or Collinsville trolley line from East St. Louis), has four blocks of Belgian furnaces, and employ both hand and mechanical roasters. Though located over a coal mine it has been closed by the competition of the cheaper fuel in the Kansas gas belt.

LEAD MINES

Lead Mines in Southeastern Missouri.

Missouri ranks second as a lead producer, being exceeded only by Idaho, and most of its output comes from the southeastern district, of which St. Francois County is the center.

Zinc Mining in Southwestern Missouri.



ZINC MINING IN SOUTHWESTERN MISSOURI.

Lead Mining In Southeastern Missouri.

A small amount from this district is produced from small but rich pipe veins and surface deposits in Washington and Jefferson Counties, where it is associated with barite or "tiff." The large producers work low grade horizontal runs or chutes of galena that is disseminated in a Cambrian magnesian limestone. The mine run of ore yields from 3 to 4% lead, and occurs at depths of 200 to 500 feet. The ore is crushed and concentrated to assay 65 to 72% lead by mills designed on the English, German and American systems. The concentrates are either smelted locally or shipped to East St. Louis or eastern smelters. The smelting process employed at the large mines is either the Flintshire or else roasting in reverberatory furnaces and smelting in water-jacket furnaces, finally refining by steam poling. A few Scotch-hearths are still to be found in Washington and Jefferson Counties for smelting the output of the small mines.

This southwestern district is reached by either the Iron Mountain R. R. or the Memphis branch of the Frisco R. R.

The principal mines are:

Lead Mines.

The St. Joe Lead Co., at Bonne Terre, 60 miles south of St. Louis (Shepherd House), which owns over 25,000 acres, operates 12 shafts and produces about 25,000 tons pig lead a year, which makes it one of the largest lead mines in the world (capital $6,000,000). It has an English system concentration mill at Bonne Terre of 1500 tons daily capacity designed on original ideas, and a new American system mill of 1200 tons capacity at Owl Creek, eight miles southwest of Bonne Terre, of excellent modern design. Its smelting plant is located at Herculaneum, 30 miles south of St. Louis, on the Mississippi River, and has a capacity of 200 tons a day. This company also owns the M. R. & B. T. R. R., some 60 miles long, a well-built standard gauge road that connects with all the mines in St. Francois County.

The Doe Run Lead Co. operates four shafts at Flat River, eight miles south of Bonne Terre, and a 1200 ton mill at Doe Run that is a counterpart of that of the St. Joe Co., with which it is affiliated. Their mines are very wet, pumping from 2,500 to 4,000 gallons per minute, and have a total pumping capacity of 14,000 gallons, using compound steam pumps.

The Central Lead Co., at Flat River, operates three shafts and has a very compact, well-designed plant at the junction of the M. R. & B. T. R. R. and the Missouri Southern R. R. It has a 500-ton German system mill, an 80-ton smelter and an independent local railroad.

The Desloge Lead Co. is four miles south of Bonne Terre at Desloge (Goff House). It has a large estate and operates three shafts, a 1000-ton German system mill, and its smelting plant consists of five Flintshire furnaces and a 40-ton water-jacket plant.

'Lead Mines
In
Southeastern
Missouri.

LEAD MINING IN SOUTHEASTERN MISSOURI.

Lead Mines.

The National Lead Co., at Desloge, operates three shafts and has a well-designed, modern American system mill of 1500 tons capacity. It has a large central electric power plant for operating all departments.

The Federal Lead Co., at Flat River, operates two shafts and has a 500-ton mill designed on the Bartlett table system, no jigs being employed.

Other and smaller mines in this district are the Columbia and Union at Flat River, and the Catherine, North American and Mine LaMotte, at Fredericktown, 120 miles south of St. Louis (Madison House). The last mine has continuously produced lead for nearly 200 years, and of late years a few tons annually of nickel and cobalt motte.

Lead Smelters.

In addition to the lead smelters at Herculaneum, Flat River, Desloge and Mine LaMotte in southeastern Missouri, there are the following in this vicinity:

St. Louis Smelting and Refining Co., Macklind Avenue and Mo. Pac. R. R. (one mile south of the World's Fair), is an old silver-lead smelter that formerly operated on western and Mexican ores. Later it has been smelting Missouri ores and is now being removed to Collinsville, Ill. (Vandalia R. R.), where the Scotch hearth system will be employed.

Federal Lead Co., at Alton, Ill., 20 miles from St. Louis (via C. & A. R. R.), is a large smelter erected in 1902, and operates on the Scotch hearth process.

Picher Smelter, at Joplin (via Frisco R. R.), operates on the Bartlett process, using Scotch-hearths and slag-eyes and catching the fumes by the bag process, the latter being used for paint under the name of "blue lead."

White Lead Works.

Southern White Lead Works, Main and Lombard Streets.

St. Louis Lead and Oil Works, Howard Station.

Collier White Lead and Oil Works, Tenth Street and Clark Avenue.

Office for all these at Tenth Street and Clark Avenue.

Manufacture white lead, red lead, lead pipe, sheet lead, etc. Produce 20,000 tons of white lead per annum.

TIFF OR BARITE.

Tiff or Barite.

Missouri is the principal producer of "tiff" or barite, that is extensively used as a filler and weighter in paints, paper, etc. Most of it comes from the shallow clay diggings and the small pipe veins in Washington County, and the shipping points are Blackwell, Cadet and Mineral Point, on the Iron Mountain R. R. From 20,000 to 25,000 tons are produced a year, which is worked up in grinding mills located at Mineral Point, St. Louis and Quincy, Ill.

METALLURGICAL AND TESTING WORKS.

Sampling and Testing Works.

St. Louis Sampling and Testing Works, 1225-1227 Spruce St., W. B. Potter, Manager. An establishment for making all kinds of working tests on ores, fuels, etc., on an industrial scale. The plant includes jaw crushers, rolls and sample grinder; two stamp batteries for treating gold and silver ores, copper plates, amalgamating pans and settlers; revolving sizing screens, six plunger jigs, hydraulic separator and pointed box classifiers, Frue, Vanner and Bartlett tables; roasting furnace, coke oven and boiler equipped for fuel tests; assay and chemical laboratories.

CLAY INDUSTRIES.

Clay Industries.

Most of the clay plants are in Cheltenham, or the southwestern part of the city, and are about a mile south of the World's Fair grounds. Take the Cheltenham division of the Suburban trolley line for Hydraulic Press Brick Plants, Evans & Howard, Mitchell Clay Co., Winkle's, St. Louis Terra Cotta Co., Laclede Firebrick Co., Missouri Firebrick Co., the Jamieson-French, and the Cheltenham Fire Clay Co.

Evans & Howard Fire Brick Co., at Cheltenham, manufacture fire brick, sewer pipe, etc. Capacity 200 tons a day. Have thirty-two kilns and two pipe presses. Mine the clay in the immediate neighborhood, from the lower coal measures.

Laclede Fire Brick Co., at Cheltenham, manufacture fire brick, gas retorts, sewer pipe, fire proofing, paving brick, etc. Capacity 200 tons a day. Have twenty-seven kilns and two pipe presses. Mine the clay on the premises.

Parker-Russel Fire Brick Co., at Oak Hill Station, six miles on Oak Hill Railway. Manufacture fire brick, gas retorts, fireproofing, etc. Capacity 100 tons a day. Have sixteen kilns. Mine clay on premises.

Christy Fire Clay Co. (south of Oak Hill Station, or take south-bound Cherokee car to Gravois Ave. and Itaska St., or west-bound Southampton car to Kingshighway and Devonshire Ave.). Manufacture washed clays, fire brick and high-grade refractory material. Specialty, glass factory supplies. Capacity 350 tons daily. Have three continuous and nine single kilns. Mine their own clay.

Missouri Fire Brick Co., at Cheltenham, manufacture fire brick and gas retorts. Capacity 50 tons a day. Have five kilns.

Mitchell Clay Mfg. Co., at Cheltenham, manufacture fire brick, etc. Capacity 20 tons a day. Have four kilns.

Mississippi Glass Co.'s Pot Factory, Douglas Ave. and Wabash Railway, or Broadway trolley car to 4200 N. Broadway.

Manufacture glass pots and fire brick. Capacity 75 tons a day. Have seven kilns.

Clay Industries.

Jamieson & French, at Bartolds, eight miles west. Ship crude and washed glass pot clay and fire clay.

Bausch Clay Works, at Bartolds. Ship pot clay and fire clay.

St. Louis Vitrified & Fire Brick Co., at Bond, St. Louis County (take Creve Coeur trolley line). Manufacture fire brick, paving brick and milled fire clay. Have ten kilns and capacity of 10,000,000 bricks annually.

Blackmer & Post Sewer Pipe Works, at Reber Place (take Tower Grove trolley line). Manufacture sewer pipe up to 36 inches. Have two pipe presses and 21 kilns. Mine clay in vicinity. Annual capacity 50,000 tons of pipe.

Winkle Terra Cotta Co., at Cheltenham. Manufacture terra cotta from Missouri clays. Have eight kilns. Capacity 30 tons a day.

St. Louis Terra Cotta Co., at Cheltenham. Manufacture terra cotta. Have five kilns. Capacity 20 tons a day.

Hydraulic Press Brick Co., at Cheltenham. This company operates six yards in St. Louis and fifteen more scattered throughout the United States. Capital $3,000,000. Its main plant is at Kingshighway and Mo. Pac. R. R., where it manufactures common, press, buff, enamel and paving brick from local and St. Louis County clays by the dry press and stiff mud processes. St. Louis capacity 100,000,000; 8 hydraulic presses, two stiff mud machines, and 70 kilns. This is the largest brick company in America, with a total annual capacity of 350,000,000 bricks.

Union Press Brick Co., Kingshighway and Natural Bridge Road. Manufacture common and stock brick by wet and dry clay processes. Capacity 40,000,000; four presses and 18 kilns.

Ittner Brick Works, at Belleville, 20 miles via L. & N. R. R. Manufacture common and stock brick by dry press and hammer processes. Capacity 30,000; have four presses and 14 kilns.

Alton Paving Brick Co., at Alton, 22 miles via C. & A. R. R. Manufacture paving and building brick by the stiff mud and dry processes. Capacity 20,000,000; two presses and 10 kilns.

There are about twenty other brick yards about St. Louis of smaller size that use the soft-mud and dry-press processes, and both up and down-draught kilns.

GLASS INDUSTRIES.

Glass Industries.

A large glass industry has developed about St. Louis, due to the presence of an extensive and very pure deposit of white sand or silica, about twenty-five miles west and south of the

city. This sand is so free from iron contamination that it is largely shipped to the glass works in the Indiana gas belt.

Crystal Plate Glass Works of the Pittsburg Plate Glass Co., at Crystal City, Mo., 30 miles south of St. Louis, reached by the Iron Mountain R. R., the Memphis branch of the Frisco and by steamboat.

The plant covers twenty-six acres and contains four Siemen's regenerative glass melting furnaces with necessary gas producers, ninety-four annealing kilns, twenty-five disc grinding machines, forty-two polishing machines, boilers and Corliss condensing engines aggregating 3000 h.p., pumping plant of 5,000,000 gallons capacity per twenty-four hours and three locomotives. Six and a half miles of railroad in and around factory.

St. Louis Plate Glass Co. Works at Valley Park, Mo., 19 miles west of St. Louis, via Mo. Pac. or Frisco R. R. New and extensive works, containing four 20-pot furnaces; ware annealed in continuous Lehrs kilns.

Illinois Glass Co. Works at Alton, Ill., 22 miles north of St. Louis via C. and A. R. R. This is the largest bottle factory in the United States and produces all kinds of flint and colored bottles; eight continuous tank furnaces, three Gill pot furnaces, five day tanks.

Mississippi Glass Co. Foot of Angelica St.; take Broadway car north to 4100 N. Broadway, then walk two blocks east. Make skylight and wire glass, cathedral glass, rough plate; have two continuous regenerative tank furnaces; capacity 50 tons in 24 hours.

A. Busch Glass Mfg. Co.

(a) Main and Dorcas Sts. Manufacturers of green bottle glass. One 20-ring regenerative tank furnace, capacity 50 tons in 24 hours, the largest in the world.

(b) Belleville, Ill., 15 miles from St. Louis. Green bottle factory of the Anheuser-Busch brewery. Three continuous tank furnaces, 32 rings; capacity 82 tons in 24 hours, or the eequivalent of 164,000 bottles.

Obear-Nestor Glass Co., Broadway, East St. Louis; take car on Eads Bridge. Manufacturers of flint bottle glass; one 20-ring continuous tank, capacity 20 tons in 24 hours; one 16 and one 14-pot furnace.

Continental Glass Mfg. Co., Third and Barton Sts.; take Broadway car to Barton St., walk one block east. One 9-ring continuous tank operating on press ware.

Port Glass Works, Belleville, Ill. One 7-ring continuous tank furnace, operating on machine made fruit jars; capacity 27 tons or 54,000 jars in 24 hours.

IRON AND STEEL INDUSTRY.

Iron and Steel Industry.

Missouri was formerly an important factor in the iron and steel industry, and the old Vulcan Steel Works at South St. Louis, recently razed, was the first triumph of the great steel expert, A. A. Holley. When the famous Iron Mountain and Pilot Knob mines (ninety miles south via Iron Mountain R. R.) were producing their rich ores they supported twelve blast furnaces in St. Louis and six at the mines. Since the exhaustion of these mines about 1895, after producing about 5,000,000 tons of ore, most of the blast furnaces have been scrapped, under the severe competition of the Mesabi and southern ores, and today only one of the above furnaces is running on the remnants of Iron Mountain ore (St. Louis Blast Furnace Co.). Several charcoal furnaces formerly operated in Central Missouri on local pockets of red hematite, but they have all been scrapped, with one exception (Sligo Furnace Co.), on the exhaustion of the timber. The present steel plants are based on the advantages of St. Louis as a large scrap center rather than on the low-grade iron ores in Southern and Central Missouri.

PIG IRON INDUSTRY.

Pig Iron.

Jupiter Iron Works, Carondelet. One stack 75 by 20 feet; three Whitwell stoves. Not in blast.

Missouri Furnace Co., Carondelet. One stack 76 by 16 feet and three fire-brick stoves. Capacity 200 tons daily.

Sligo Furnace Co., at Sligo, 125 miles southwest of St. Louis; take Frisco R. R. to Cuba, thence a branch line to Sligo. One stack 55 by 11 feet, charcoal fuel; manufacture charcoal by beehive ovens and a modern by-product plant; capacity 50 tons daily.

TIN PLATE MILLS.

Tin Plate.

Granite Iron Rolling Mill, Destrahan and Third Sts.; take Broadway trolley car to 3500 N. Broadway, walk one block east.

Heimbacher Forge Co., Barton and DeKalb Sts.; take Broadway car to 2400 S. Broadway, then walk two blocks east. This company also has another plant at Madison, Ill.

Stupp Bros. Bridge Works. New bridge plant is at Grand Ave. and Weber Road in South St. Louis. Capacity 1000 tons annually.

CHEMICAL WORKS.

Chemical Works.

Mallinckrodt Chemical Works, located at Second and Mallinckrodt Sts.; take Broadway car north to Mallinckrodt St. and walk three blocks east. Manufacturers of pharmaceutical, medicinal and photographic chemicals. This plant is one of the two largest chemical works in the United States.

National Ammonia Co., located at foot of Mallinckrodt St. Manufacturers of anhydrous ammonia. This is the largest ammonia plant in the United States.

Mechanical Engineering

Laclede Gas Light Co.

THE Laclede Gas Light Co. has two large stations, one at 2d and Rutger Sts., and the other at Main and Mullanphy Sts. The one at 2d and Rutger Sts., or Station "A," has a coal gas capacity of 4,000,000 cubic feet per day, and a water gas capacity of 7,000,000 cubic feet per day. The water gas machines include some of the largest in use. From Station "A" the gas is distributed by means of a large gas pumping plant to various portions of the city through high-pressure mains, from which reducing valves cut the pressure to the requirements in the low-pressure mains. The high-pressure mains operate under a head of approximately 10 inches of water and the low-pressure mains at about 2 inches.

The plant at Main and Mullanphy Sts., or Station "B," has a capacity of 1,500,000 cubic feet of coal gas and 2,500,000 cubic feet of water gas daily. Both plants are being enlarged and will soon be doubled in capacity.

The gas storage facilities consist of a 4,000,000 cubic feet holder at Chouteau and Newstead Aves., and one of similar capacity at Broadway and Gasconade St. These holders are of the most approved type of modern structural work and are excellent examples of the modern method of storing gas.

The company has, approximately, 600 miles of main pipe and about 75,000 services.

The equipment in all departments is being extended rapidly and the additional apparatus being purchased is of the most modern and best type that can be procured.

Rope Factories.

Broderick and Bascom Rope Co., 805-809 N. Main St., manufacturers of wire rope and cordage. Founded in 1875; plant covers three acres; complete equipment of latest types of high-speed rope machines, designed and patented by Mr. E. P. Frederick. All wires tested on an automatic machine before laying up into strands; welds are formed electrically.

The product of the works includes cables from four inches in diameter down to the smallest picture cords. Can produce cables in one piece weighing 70 tons.

The entire works, including new machine shops, will shortly be equipped for individual motor drives designed for variable speed.

Rope Factories.

A. Leschen & Sons Rope Co., 920-932 North First St., and Second St. and Bremen Ave.

A new plant, covering 30 acres, has recently been erected in the western part of the city on the St. Louis Merchants' Terminal Belt Line. The output of this large plant includes Patent Flattened Strand and Hercules Wire Rope; complete aerial, wire rope, tramway equipments of several types; manila and sisal rope, and all auxiliaries used in connection with wire rope.

This company has an exhibit in the Mines and Metallurgy Building of the Louisiana Purchase Exposition, and a full-sized working model of an aerial tramway in connection with the outdoor mining exhibit.

Refrigerating Plant.

St. Louis Refrigerating and Cold Storage Co., Lewis and O'Fallon Streets.

Both standard types of ammonia refrigerating machines are used, absorption and compression. All ammonia condensing and cooling apparatus are of the two-pipe type. Mechanical stokers in connection with coal and ash handling and weighing machinery are used. A cold storage warehouse, can system ice plant, and pipe line refrigeration distributing system are operated from one building. Warehouse contains one million cubic feet. An indirect forced air circulating system is used. The ice plant has an output of 120 tons per day. The pipe line is being extended. There are now over five miles of the system laid, distributing refrigeration directly to the cold storage boxes and rooms of markets, hotels, clubs, restaurants, etc.

A cordial invitation is extended to visiting engineers. R. H. Tait, Mechanical Superintendent.

FOUNDRIES

Steel Castings.

The St. Louis district is an important center for the manufacture of steel castings by the basic open-hearth process; annual capacity of neighboring plants 150,000 tons. An average analysis of the steel castings assays:

Carbon	0.20
Manganese	0.80
Silica	0.30
Phosphorous	0.035 to 0.01
Sulphur	0.035 to 0.01

The manufacture of cast steel railway trucks originated in St Louis and has reached a high state of development. The following plants are open to visitors:

Steel. Foundries.

Commonwealth Steel Co., Granite City, Ill.; take Merchants Bridge R. R. from Union Station, or from foot of Washington Ave., trains hourly. Manufacture steel castings exclusively, mostly for railroad work. Have four 30-ton furnaces and use fuel oil from Neodesha, Kansas. The plant is a modern one with steel buildings, served by traveling cranes. Capacity 125 tons daily.

American Steel Foundries, Granite City, Ill., adjoin above plant. Manufacture railroad appliances exclusively. Have five 20-ton furnaces and use fuel oil. Capacity 125 tons daily.

With the steel foundry is a pressed-steel car plant with a capacity of ten cars daily.

American Steel Foundries, Granite City, Ill., adjoin above St. Louis, Ill.; take Broadway car crossing Eads Bridge at foot of Washington Ave. Manufacture steel castings for railroad work. Have four 30-ton Wellman & Sieber oil-burning tilting furnaces. It is a well equipped modern plant with a capacity of 125 tons daily.

Scullin-Gallagher Iron and Steel Co., Manchester Ave. and Kratt St.; take Cheltenham car on Suburban trolley line. Manufacture steel castings. Have 25-ton furnaces using producer gas as fuel. Modern plant, thoroughly equipped. Capacity about 125 tons daily.

List of iron foundries in St. Louis and vicinity:

Iron Foundries.

National Enameling and Stamping Co., Granite City, Ill.; take Merchants Bridge R. R. from foot of Washington Ave.; trains hourly. Have four 50-ton basic open-hearth furnaces, ingot, blooming and universal mills. Capacity, 250 tons daily of $\frac{5}{8}$-inch steel plate that is converted into stamped ware.

Tudor Iron Mill of Republic Iron and Steel Co., East St. Louis, Ill., at 6th and Piggott Sts.; take car at Eads Bridge at foot of Washington Ave. Erected in 1873. Equipped with puddling, scrap and heating furnaces, Siemens' gas producers, five trains of rolls, and bolt and spike machines. Manufacture light rails, spikes, splice-bars, etc. Annual capacity 50,000 tons.

Carondelet Foundry Co., 2123 S. Kingshighway. 750 tons light grades of gray iron castings monthly.

Green's Car Wheel Mfg. Co., 3018 N. Broadway. 1000 tons machinery castings monthly.

Arthur Fritch Foundry and Machine Co., 1 cupola, 216 Gratiot St. General machinery castings.

Globe Iron and Foundry Co., 9th and Victor Sts., 1 cupola. Structural iron castings.

Pleugger and Henger Mfg. Co., 11th and Eagle Sts., 1 cupola. Water works castings, iron and brass.

St. Louis Malleable Casting Co., 7701 W. Converse St. 1000 tons malleable iron castings, 300 tons gray iron castings, 1000 car wheel castings, monthly.

St. Louis Iron and Machine Works, Main St. and Chouteau Ave., 2 cupolas. Heavy machinery and engine castings. Manufacturers of St. Louis Corliss engines.

South St. Louis Foundry, 7514 S. Broadway.

Banner Iron Works, Shaw Ave. and Oak Hill Ry., 1 cupola. Structural iron castings.

Christopher & Simpson Architectural and Iron Foundry Co., 9th St. and Park Ave., 1 cupola. Structural iron castings.

Gerst Bros. Mfg. Co., 800 Cass Ave., 1 cupola. Structural iron castings.

Koken Iron Works, Manchester and Chouteau Aves., 1 cupola. Structural iron works.

Magnetite Foundry, 3820 Manchester Ave.

Central Union Brass Co., 11th and Mullanphy Sts. Brass and gray iron castings.

Electrical Engineering

STREET RAILWAYS

St. Louis Transit Company.

1. Miles of street occupied in city limits, 176.41.
2. Miles of single track, 358.65.
3. Number of cars to be operated during the World's Fair, 1,500.
4. Passengers carried in 1903, including transfers and passes, 210,000,000.
5. Kind of rail, standard 9-inch groove, concrete stringer construction.

List of machinery in the different power stations:

Central Station, Park and Vandeventer Aves.

Engines:

Three 20 and 40 by 30-inch tandem compound non-condensing Porter-Allen engines, 150 rpm., direct-connected to 1500 k.w. generators.

Four 36 and 70 by 60-inch cross compound Fulton Iron Works condensing engines, 75 rpm., direct-connected to 2250 k.w. Westinghouse generators.

Two 32 and 62 by 60-inch Fulton Iron Works cross compound condensing engines, 75 rpm., direct-connected to 1500 k.w. Westinghouse generators.

Boilers:

Sixteen 400 h.p. O'Brien water-tube boilers equipped with Green traveling chain grate stokers and Hoppes purifiers. All heaters in this station are of the Excelsior type.

Eight 325 h.p. Stirling boilers.

Six 400 h.p. Stirling boilers equipped with Hawley down-draft furnace and Hoppes purifiers.

Coal and ashes handled by McCaslin conveyor.

Condensers:

Two Worthington jet condensers.

Twelve cooling towers.

Two 1-million duplex triple-expansion Epping-Carpenter pumps.

Six centrifugal pumps.

Three dry-vacuum pumps.

Northern Station, Broadway and Salisbury Sts.

List of Machinery in Northern Station.

Engines:

Two 36 and 70 by 60-inch cross-compound condensing engines, built by Fulton Iron Works, 75 rpm., direct-connected to 2250 k.w. G. E. generators.

Two 28 and 56 by 60-inch cross-compound condensing engines, 75 rpm., built by Fulton Iron Works, direct-connected to 1500 k.w., three-phase G. E. generators, 6600 volts, 25 cycles.

Boilers:

Sixteen 400 h.p. O'Brien water-tube boilers equipped with Green traveling chain grate stokers, Hoppes purifiers and Excelsior open heaters.

Condensers:

Two Wheeler surface condensers, 10,000 square feet cooling surface, with two Conover air pumps and two Knowles' circulating pumps; also four cooling towers on roof of building; coal and ashes are handled by McCaslin conveyor; Epping-Carpenter feed pumps.

Geyer Ave. Station, Jefferson and Geyer Aves.

List of Machinery in Geyer Avenue Station.

Engines:

One 36 by 48-inch Allis engine direct-connected to 800 k.w. G. E. generator.

One 28 by 54-inch Hamilton Corliss belted to 500 k.w. Westinghouse generator.

One 36 by 60-inch Allis twin direct-connected to 1500 k.w. G. E. generator.

Two 22 by 60-inch Porter-Allen engines direct-connected to 400 k.w. G. E. generators.

One 38 by 60-inch Allis engine direct-connected to 1050 k.w. G. E. generator.

One 36 by 60-inch Rankin-Fritch direct-connected to 800 k.w. G. E. generator.

One 22 by 42-inch Allis twin direct-connected to 600 k.w. Western Electric booster.

Boilers:

Seven 500 h.p. Heine.
Four 300 h.p. Babcock & Wilcox.
Two 250 h.p. O'Brien.
Nine 250 h.p. Heine.

Twelve of these boilers are equipped with down-draft furnaces and the remainder are straight fired; feed water heaters are of the Cochrane type and switchboard of the G. E. type.

St. Louis Transit Company.

Cass Avenue Station, Spring Avenue and North Market St.

Engines:

Three 34 by 60-inch Allis engines, 94 rpm., direct-connected to G. E. 800 k.w. generators.

One 18 by 36-inch Allis, 150 rpm., direct-connected to 150 k.w. G. E. generator.

Boilers:

Sixteen 200 h.p. tubular boilers with Hawley down-draft furnaces.

One old-type link-belt ash conveyor.

Central Sub-Station, 1711 Locust St.

One 3000 k.w. Electric Storage Battery Co.'s storage battery.

Seven 1000 k.w. General Electric rotaries.

Two 252 k.w. General Electric boosters and complete D. C. and A. C. switchboards with transformers, etc., of General Electric type.

Delmar Sub-Station, Delmar and DeBaliviere Aves.

Four 600 k.w. rotary converters, with necessary A. C. and D. C. switchboards, transformers, etc., of G. E. type.

St. Louis and Suburban Railway Co.

The total number of cars is 164, of which 75 are new and weigh 24 tons each. The older cars are being reconstructed and will have four motor equipments.

The main power plant at DeHodiamont will contain, when completed, the following equipment:

Three 800 k.w. G. E. Co.'s direct-current railway generators, each direct-connected to single cylinder Corliss engines, two of which are the Hamilton type and one of the Allis-Chalmers type.

Three 1200 k.w. G. E. Co.'s three-phase alternators, 6600 volts, 25 cycles. Each alternator driven by cross-compound engines, two of which are Allis-Chalmers and one of Fulton Iron Works.

Two 300 k.w. G. E. Co.'s direct-current railway generators, belted to one Hamilton Corliss engine.

Engines are non-condensing and take steam at 175 pounds.

Thirteen 545 h.p. O'Brien water-tube boilers.

Sub-Station, 16th and Wash St.

Three 600 k.w. rotary converters, with air-blast transformers.

Sub-Station at Brentwood.

One 500 k.w. direct-current generator.

Two 600 k. w. rotary convertors.

Eight boilers of total capacity of about 900 h.p.

St. Louis St. Charles and Western Railway.

This is a suburban road, running from Wellston, at the city limits of St. Louis, to St. Charles, Mo. The road is a single track, twenty miles long, served by sixteen motor cars equipped with General Electric motors. The power plant contains 900 h.p. capacity in boilers, and about 600 k.w. in engines and generators. The road crosses the Missouri River at St. Charles on a recently completed toll bridge.

East St. Louis and Suburban Electric Line.

The East St. Louis & Suburban Railway Company operates the trolley lines within the city limits of East St. Louis and the electric service on the Eads bridge between St. Louis and East St. Louis.

They also operate the interurban electric passenger service between East St Louis and Belleville, between East St. Louis and Edwardsville, between East St. Louis and Lebanon, and in the city of Belleville.

The Company has 24.7 miles of single track in East St. Louis. The length of trip from the St. Louis end of Eads Bridge to Belleville is 14.3 miles, to Edwardsville 23.0 miles and to Lebanon 23.4 miles.

The freight service is divided into two branches, one between East St. Louis and Belleville, touching the coal mines in this section, and the other between East St. Louis and Lebanon, supplying service to numerous coal mines near O'Fallon and Lebanon. The freight traffic on the East St. Louis-Belleville division is handled by two 50-ton electric locomotives, while the East St. Louis-Lebanon division has steam locomotives.

The electric lighting for East St. Louis is also furnished by the same company.

Electric power for the entire system above mentioned is supplied from one central station situated in East St. Louis on Ridge Ave. This power station supplies 575 volt direct current for the city railway service; 13,200 volt, 25 cycle, alternating current to the sub-stations for the suburban railway service; 2300 volt, 60 cycle, alternating current for the city arc and incandescent lighting service, and 550 volt direct current for power service.

The sub-stations receive the 13,200 volt A. C. current and convert it into 575 volt direct current. These sub-stations are three in number, and are situated respectively near Maryville, O'Fallon and Edgemont.

Some of the features differing from similar installations in this vicinity, are the use of aluminum wire for high tension transmission and railway feeders, the employment of motor generator sets for the production of the 2300 volt lighting current, and the use of electric locomotives for freight service.

LIGHTING PLANTS

Electric Light Stations.

The Union Electric Light & Power Company is operating at this date three electric light stations.

The Tenth St. Station (Tenth and St. Charles Sts.) is equipped with eight 360 h.p. Heine boilers and four 445 h.p. Heine boilers; one 1500 k.w. direct-current Westinghouse generator direct-connected to cross-compound engine; four Siemans & Halske generators, direct current, 500 k.w., direct-connected to two cross-compound engines by Arnold magnetic clutches; one 500 k.w. direct-current Siemans & Halske generator direct-connected to cross-compound engine; two 500 k.w. rotary convertors, three phase, 25 cycle, 6600 volt primary, through step-down transformers. This station contains a storage battery capable of giving a 1000 ampere discharge for one hour. The station is wired for three-wire Edison system with voltage of 235/470.

Station "A," 20th and Locust Sts., is a single-phase alternating plant with a frequency of 60 cycles. The generating equipment consists of three 800 k.w., Westinghouse two-phase alternators, direct-connected to three-cylinder compound engines, and one 300 k.w. single-phase 60-cycle alternator direct-connected to Westinghouse compound engine. This station operates at a bus bar voltage of 1150 volts alternating. The station is provided with Babcock & Wilcox boilers, 14 boilers being rated at 208 h.p. each, and 4 boilers at 235 h.p. each.

Station "B," 19th and Gratiot Sts., has an equipment of two 800 k.w. and one 1500 k.w. alternators. These machines are General Electric, monocyclic, 60-cycle generators, but are operated as single-phase machines. One 800 k.w. alternator is direct-connected to a single-cylinder Corliss engine. The remaining alternators are each direct-connected to cross-compound engines. The bus bar voltage for this station is 1150 volts alternating. This station also contains one 450 k.w. direct-current railway generator, 500 volts, and two direct-current generators, each about 300 amperes at 550 volts. The railway generator is direct-connected to a single-cylinder Corliss engine. The two smaller generators are each belt-connected to a Westinghouse compound engine. This station contains sixteen 375 h.p. Heine boilers.

The company is building a plant on the river, east of Lewis St., between Ashley St. and Biddle St. This plant will be a central station power plant operating at 6600 volts, 25 cycle, three phase. The installation, when completed, will consist of three 3000 k.w. alternators direct-connected to cross-compound engines; two 1500 k.w. alternators direct-connected to cross-compound engines; two 2000 k.w. Curtis turbine units, and four

5000 k.w. Curtis turbine units. The boiler plant will consist of twenty-six boilers of the three-furnace gunboat type, 600 h.p. each. Thirty-eight additional boilers are to be installed, design not yet perfected.

Electric Light Stations.

This central station will feed sub-stations in various parts of the city. The concentrated business districts will be supplied with direct-current three-wire system, and the outlying districts will be supplied with alternating current at 2300 volts primary.

Laclede Power Company.

The plant located at Lewis and Ashley Sts., contains two 500 k.w., 550 volt, G. E. direct-current generators, direct-connected to Hamilton Corliss engines, and supplied with steam by O'Brien boilers; and one 500 k.w. Curtis turbine unit.

FACTORIES

Wagner Electric Mfg. Co.

Manufacturers of single-phase, alternating-current power motors, direct-current power motors and generators, indicating switchboard instruments and static transformers of all kinds.

Full exhibit of apparatus in Block 9, Electricity Building, Exposition grounds.

The Emerson Electric Mfg. Co.

Manufacturers of alternating-current desk fans, ceiling fans, and power motors up to 2½ h.p.; also of direct-current motors up to 2½ h.p. Capacity of plant 100 to 150 motors daily.

Shops and elevators electrically driven by two 50 k.w. 500-volt generators; lighting on three-wire system, using balancer set.

The Columbian Incandescent Light Co.

Manufacture all kinds of incandescent electric lamps. This company has been established in St. Louis since 1889, and employs about 200 men and women.

A cordial invitation to visit the factory is extended to all engineers visiting St. Louis during the Exposition.

A. C. GARRISON, President.

TELEPHONE COMPANIES

Bell Telephone Company.

It is of interest to note that the telephone system of St. Louis dates back to the year 1878. On May 1st of that year one of the first telephone exchanges in the United States was put into service in this city, with only a few subscribers and less than one hundred miles of outside wire. From this small beginning the system has grown to one of importance, until now it covers the cities of St. Louis, East St. Louis, the suburban towns of Belleville, St. Charles, Kirkwood and Webster, and a large toll line territory in Missouri and Illinois.

Telephone Exchanges.

The system in St. Louis comprises eight exchanges, viz: "Main," in the Telephone Building at 10th and Olive Sts.; "Beaumont," at Beaumont and Locust Sts.; "Lindell," at 3844 Olive St.; "Forest," at 5144 Delmar Ave.; "Grand," at 1625 S. Grand Ave.; "Sidney," at 11th and Sidney Sts.; "South," at

Telephone Exchanges.

6817 Minnesota Ave.; "Tyler," at 11th and Chambers Sts. In East St. Louis there is one exchange known as "Bridge," or "East," at 105 Collinsville Ave. In conection with these exchanges there is an extensive underground conduit system running in forty miles of streets and alleys, containing a total wire mileage of 27,000 miles in cables, ranging in size from one to four hundred and eighty pair. For alley and street distribution there are two hundred miles of pole lines with an approximate wire mileage of twenty thousand miles, of which about seventy-five per cent is in aerial cable.

In the toll line system there are three thousand miles of toll line wire covering, with some exceptions, sparsely populated territory.

In general, all the exchanges are equipped with common battery relay type of switchboards. The later offices, such as Beaumont, Grand and Forest, all are equipped with switchboards with a capacity of 9600 multiple jacks. The equipment at Main was the second common battery multiple switchboard to be installed in this country, and was the largest board manufactured at that time. It has a capacity of 5600 multiple jacks, and was put into service in the early part of the year 1898. This office has lately been equipped with an incoming trunk board of 9600 capacity, and a complete new power and storage battery plant.

The power plant has an output of 36 k.w. The storage battery plant consists of two sets of batteries with a discharge rate for eight hours of 400 amperes. The Main exchange, with the additional equipment ordered, will be one of the largest exchanges outside of New York City.

Of the later exchanges which have been constructed, Forest is a typical example and represents the best telephonic engineering of the present day, it being complete in all details and equipped with the latest and most approved apparatus now manufactured. The building is 33 feet by 107 feet and consists of a ground and first floors. The telephone cables enter the building from the rear, and lead through a subway to the main frame; from there cable is run as usual to the intermediate frame and thence to the switchboards on the first floor.

The power room is equipped with ringing generators, motor generators, gas engine, etc., the plant having an output of 10 k.w.

The battery room has two sets of batteries, having a combined discharge rate for eight hours of 225 amperes.

The switchboard equipment in the operating room consists of a local board and an incoming trunk board, with a capacity of 9600 subscribers' multiples and 600 outgoing trunk multiples.

The traffic of the toll and long distance lines is handled by the latest type of switchboards, located in the Beaumont exchange building.

The Kinloch Telephone Co., Century Building, 9th & Olive Streets.

The equipment at the Main exchange in the Century Building consists of a four-division multiple switchboard, having an ultimate capacity of 20,000 subscribers' lines, and is the only one of its kind in operation. The storage battery in use in connection with this exchange has the largest capacity of any used for telephone purposes in the world. The daily number of connections exceed that of any other single exchange in the country.

Exchanges:

"Delmar," located at Delmar and Newstead Aves., has a line capacity of 7200, with a 22-volt common battery switchboard.

"Victor," located at Ann and Indiana Aves., has a line capacity of 7200, with a 44-volt common battery switchboard.

"St. Clair," located at 5th and Missouri Aves., East St. Louis, Ill., has a line capacity of 5,000, with a 44-volt common battery switchboard.

The outside equipment consists of 21,000 miles of wire and cable, partly of aerial and partly of underground construction; 300 miles of pole line, 228 duct miles of vitrified shale (McRoy) multiple conduit laid in concrete. Cables vary in sizes from 400 pair to one pair.

General

Cupples Station.

THIS consists of a group of wholesale stores and railway warehouses combined with a union freight station, and is the largest private freight station in the world. The buildings are of slow burning construction type and cover two and one-half city blocks.

These buildings are occupied by the largest wholesale grocery, hardware and woodenware houses in the city. They are especially interesting as a solution of the problem of handling freight direct to and from the various buildings to the cars without the use of teams.

Switches from the main tracks of the Terminal Railway Association, which includes all the lines entering the city, run alongside and under the buildings. One hundred and fifty cars have been handled on these spur tracks in twenty-four hours.

Mechanical engineers will be especially interested in the large elevator plant. The system is high pressure hydraulic and sixty-four freight and passenger elevators are operated from the central station. The medium for transmission is a special hydraulic oil of very high fire test, on account of underwriters' requirements, and which retains its fluidity at a temperature considerably below zero F. The available pressure on the elevator rams is seven hundred and fifty (750) pounds per square inch.

The entire system of buildings is supplied with heat, light and power from a central plant. All of the buildings are equipped with automatic sprinklers and every possible precaution is taken against fire, and although much of the stock is of a highly inflammable character the insurance rates are as low as any in the city. The entire property included as Cupples' Station is owned by the Washington University.

Typical Mercantile Building.

Carleton Building, 12th St. and Washington Ave.

Boilers—Three water-tube, 1375 square feet heating surface each, 135 pounds pressure; down-draft furnaces.

Engines—Three 12 and 18 by 14-inch, 270 rpm.

Dynamos—Three 100 k.w., 220 volt, direct-current, direct-connected.

Electric elevators—Three passenger, 2000 pounds, 400 feet per minute; five freight, 3000 pounds, 275 feet per minute; two one-story lifts, 4200 pounds, 100 feet per minute.

Other motors—About 30 h.p. of various sizes.

Lights—200 arc lamps and about 500 incandescents, wired on 110-220 volt 3-wire system; battery balancer.

Battery—46 k.w. on one hour discharge; 140 cells.

Heating—First floor and basement, indirect system, 6800 lineal feet of 1-inch pipe in coil; upper floors, direct heating, 19,062 square feet. Paul system used throughout; Thomas Acme air washing apparatus with indirect system.

Shoe Factories.

Hamilton-Brown Shoe Co.'s Factory, 21st and Locust Sts.

Boilers—Two water-tube, 2500 square feet heating surface each, 125 pounds pressure; down-draft furnaces.

Engines—One Corliss 16 and 26 by 42-inch, 100 rpm.

Dynamos—One 250 k.w., 220-volt, 3-phase, direct-connected.

Motors—322 h.p., 220-volt, 3-phase.

Lights—About 2200 125-volt lamps on 3-phase 4-wire system.

Elevators—Two steam driven, one 500-volt electric, the latter using central station power.

Heating system—All direct radiation with Paul system.

Hamilton-Brown Shoe Co.'s Factory, 23d and Randolph Sts.

Boilers—2 water-tube, 2550 square feet heating surface each, down-draft furnaces, 125 pounds perssure.

Engines—One Corliss 16 and 26 by 42-inch, 100 rpm.

Dynamos—One 250 k.w., direct-current, direct-connected, 220 volts.

Motors—308 h.p., 220-volt, direct-current.

Lights—About 2000 incandescent lamps, 110-220 volt system, with motor-generator balancer.

Elevators—Three electric, 2000 pounds, 150 feet per minute.

Heating—Direct radiation with both Paul and Webster systems.

Car Building.

St. Louis Car Co., 8000 N. Broadway.

Builders of coaches, cars and trucks, manufacturers of seats, curtains, arc headlights and arc lamps for interior car lighting. Parent plant, located at Baden, covers forty-five acres. Laclede branch, located at 4500 N. Second St., covers about five acres. Average number of employes in 1903, 2500. Capacity of Baden plant, 3000 cars per annum; Laclede plant, 500 cars per annum. Brass, gray and malleable iron foundry located at Baden plant.

The American Car Company, 1525 Old Manchester Road.

Builders of cars and trucks for street and interurban railways. The plant and equipment of this company are of the most modern design. The buildings cover an area of ten acres. The capacity of the plant is approximately three and one-half cars per day.

Breweries.

Anheuser-Busch Brewery, Office and Works at 9th and Pestalozzi Streets.

Area covered by plant, 125 acres; number of employees, 5000.

Daily capacity of brew house, 6000 barrels; bottling works, 800,000 bottles; malt house, 9000 bushels; storage elevators, 1,250,000 bushels; stock house, 450,000 barrels; steam power plant, 7750 h.p.; ice and refrigerating plants, 3300 tons, electric light and power plant, 4000 h.p.

Total output for 1903, 1,201,762 barrels.

Equipment:

Boilers—Boiler house No. 1, eleven Heine safety boilers, 450 h.p. each; boiler house No. 2, total capacity of 2200 h.p.; boiler house No. 3, five Heine safety boilers, 300 h.p. each.

Refrigerating machines—Plant No. 1, Seven De la Vergne machines, ranging from 75 to 500 tons capacity; total capacity, 1725 tons; Plant No. 2, one De la Vergne machine, capacity 470 tons.

Electric Plant—Two 500 k.w., 220-volt direct-current generators, each direct-connected to 800 h.p. compound condensing engines; two 200 k.w., 220-volt direct-current generators, direct-connected to 300 h.p. DeLaval steam turbines (now being erected).

Water Works (near the river)—Three Worthington triplex electric pumps, each of 2,000,000 gallons capacity; one centrifugal pump now being installed; two steel settling tanks, each 75 feet in diameter and 20 feet high; one settling reservoir, capacity 1,000,000 gallons.

Mechanical Filter Plant—Twelve 14-foot filters.

Glass Works—Furance capacity, 35,000 to 40,000 gross bottles per month; daily melt, 150 tons; employs between 450 and 500 people.

Railroad—Six miles of switch tracks, operated by two steam locomotives.

Wm. J. Lemp Brewing Co., Broadway, Cherokee St. and Lemp Ave.

The plant of the Wm. J. Lemp Brewing Co. covers an area of about ten city blocks. The bottling department is the largest and most scientific establishment of its kind in the world, being equipped with all the latest appliances known to science and the brewers' art. It is operated entirely by electricity. The ice plant consists of five double-acting De la Vergne machines, having a total capacity of 1000 tons of ice daily. Of this amount 250 tons are sold to consumers and the balance is used by the brewery. About 700 men and 200 horses are employed, also a number of electric trucks and delivery wagons. The Western Cable Railway Co., an offspring of the brewery, connects the brewery with the Iron Mountain R. R., affording direct shipping facilities.

Visiting engineers are extended a cordial invitation to inspect the plant in all its branches.

DIVISION III.

Local Engineering Data

FOR

St. Louis, Mo., U. S. A.

and Vicinity.

Sub-Committee in Charge:
WILLIAM H. BRYAN, Chairman.
S. BENT RUSSELL.
A. S. LANGSDORF.

May, 1904.

Local Engineering

WHERE no authorities are given the data has been collected by the Committee from various sources believed to be trustworthy.

The Engineers' Club of St. Louis does not, of course, guarantee the accuracy of any of the figures, its Committee having acted simply as compilers.

Geodetic and Astronomical Data.

GEODETIC AND ASTRONOMICAL DATA

Compiled for former location of Washington University Observatory, near southeast corner of 18th and St. Charles Sts.

Longitude west from Greenwich.....6 h., 00 m., 49.26 s.
Longitude west of Washington (new obs.).....0 h., 52 m., 33.48 s.
Local time slower than standard time.....49.26 s.
Astronomical latitude .....38°, 38′, 03″.0.
Geocentric latitude .....38°, 26′, 40″.3.
Logarithm of radius vector of the earth.....9.999429.
One degree of latitude equals.....68.970 statute miles.
One degree of longitude equals.....54.097 " "
Altitude of sun crossing meridian, winter solstice.....27°, 56′.5.
Altitude of sun crossing meridian, summer solstice.....74°, 49′.2.
Longest day .....14 h., 52 m., 16 s.
Shortest day ..... 9 h., 27 m., 44 s.
Sun sets, on longest day.....31°, 24′.7 north of west.
Sun sets, on shortest day.. .....29°, 51′.2 south "

City Directrix and Topography.

CITY DIRECTRIX AND TOPOGRAPHY

The datum of City Topography is the City Directrix, which was formerly the surface of a stone opposite No. 4 South Levee, removed some years ago. It marked the high water of 1826, and was 412.731 feet above mean tide water of the Gulf of Mexico, at Biloxi.

The highest point in the City is at the Female Hospital, near Arsenal St. and Sublette Ave., where the elevation is 202.6 feet.

Other important points have elevations as follows:

Bank of Compton Hill Reservoir.....180 ft.
Corner Broadway and Olive Street..... 56 "
Corner Grand Avenue and Olive Street.....118 "
Union Station Midway..... 43 "
Washington University (Administration Building, World's Fair), paving under archway, west side.....130 "

CLIMATE

Observations Covering the Years 1871-1903.

Observations Covering the Years 1871-1903.

Furnished by Mr. Edw. H. Bowie, Local Forcaster,

U. S. Weather Bureau.

Temperatures, Degrees Fahrenheit.

Monthly Means.

MONTH.	HIGHEST.		LOWEST.		
	Degrees.	Year.	Degrees.	Year.	Average.
January	46.8	1880	22.2	1881	31.8
February	44.6	1882	24.1	1899	34.5
March	54.3	1878	39.0	1890-1891	43.8
April	64.8	1896	47.3	1874	56.6
May	73.0	1896	60.2	1882	66.4
June	80.6	1901	70.4	1903	75.5
July	87.4	1901	74.9	1891	79.5
August	83.8	1881-1900	72.6	1875	77.6
September	77.4	1897	65.0	1890	70.2
October	66.3	1897	52.1	1873	58.9
November	53.3	1902	33.0	1880	44.5
December	49.8	1889	24.7	1876	36.0
Annual	57.6	1887	52.8	1875	56.3

Maximum and Minimum Temperatures.

Temperatures.

MONTH.	MAXIMUM.					MINIMUM.				
	U. S.			Dr. E. *		U. S.			Dr. E *	
	Deg.	Date	Year	Deg.	Year	Deg.	Date	Year	Deg.	Year
Jan.	74	11	1890	72	1843	-22	5	1884	-23	1873
Feb.	78	4	1890	81	1840	-16	12	1899	-15	1856
March	85	29	1895	86	1842	3	7	1899	0	1848
April	91	29	1899	93	1838, '55	22	17	1875	18	1857
May	94	31	1895	97	1870, '71	32	2	1875	29	1851
June	102	29	1901	102	1870	44	6	1894	43	1838-39
July	107	24	1901	104	1860	55	9	1891	53	1859
Aug.	106	12	1881	102	1850-61	52	24	1887	45	1863
Sept.	102	5	1881-89	102	1864	37	30	1899	35	1838
Oct.	91	5	1897	91	1867	24	25	1887	21	1863
Nov.	82	13	1879	80	1850	5	29	1872	0	1839-45
Dec.	74	31	1875	74	1861, '75	-17	24	1872	-20	1872

*Observations of Dr. Geo. Engleman, 1838-1881.

Humidity and Cloudiness.

Humidity and Cloudiness.

MONTH.	PERCENTAGE.		NUMBER OF DAYS.			
	Relative Humidity.	Cloudiness.	Clear.	Partly Cloudy	Cloudy.	With Precipitation.
Jan.	73	52	10	10	11	9
Feb.	72	54	9	9	10	9
March ..	69	55	9	12	10	11
April	64	50	10	12	8	10
May	67	50	11	12	8	12
June	69	48	9	15	6	12
July	67	43	13	13	5	10
Aug.	67	39	14	13	4	8
Sept.	67	38	15	10	5	7
Oct.	65	37	16	9	6	7
Nov.	69	51	10	10	10	9
Dec.	72	57	9	10	12	10
Average	68	48	135	135	95	114

Length and Severity of Winters.

(1871-1903.)

Earliest first killing frost, Sept. 30, 1899.
Latest first killing frost, Nov. 28, 1902.
Earliest last killing frost, Feb. 27, 1878.
Latest last killing frost, May 22, 1883.
Average first killing frost, Oct. 29th.
Average last killing frost, April 4th.
Maximum depth of freezing below surface of the ground, about 3 feet.
Maximum thickness of ice frozen naturally, about 15 inches.

Rainfall.

Rainfall.

Monthly rainfalls of over 10 inches have been observed once in April, twice in May, five times in June, once each in July, September, November and December.

The most violent rain on record occurred August 15, 1848, when 5.05 inches fell in seventy-five minutes. During that same year, between May 6 and August 15, there were five rains which gave an aggregate rainfall of 24 inches, the actual duration of rainfall being thirty-eight hours.

The monthly rainfall has been less than half an inch 23 times since 1838. In 1849, during August and September, the rainfall was only 0.75 inch. The three months preceding, however, gave a rainfall of 26 inches.

At Oregon, Holt Co., Mo., rainfall observations from 1855 to 1890, by Wm. Kaucher, show that the annual rainfall has varied from 27 to 49 inches. The average was 35.97 inches. The highest monthly rainfall there was 14.91 inches, in June, 1883. The rainfall has been over 10 inches once each in May, June, July, since 1855; six times the monthly rainfall has been less than 0.25 inch, the least, 0.03, occurring February, 1870.

Precipitation in Inches.

Precipitation in Inches.

Observations of Dr. Geo. Engleman, 1838-1881.

MONTH.	MAXIMA.		MINIMA.		MEAN.
	Ins.	Year.	Ins.	Year.	Ins.
January	4.66	1855	0.39	1881	2.19
February	7.74	1857	0.55	1868	2.54
March	8.61	1865	0.79	1853	3.60
April	7.68	1850	0.25	1871	3.72
May	11.26	1844	0.96	1879	4.60
June	17.07	1848	0.41	1864	5.22
July	10.00	1875	0.84	1846	4.14
August	9.74	1848	0.04	1873	4.07
September	10.53	1866	0.02	1871	2.90
October	8.74	1847	0.29	1872	2.96
November	8.63	1847	0.00	1865	2.89
December	10.90	1846	0.19	1876	2.86
Annual	68.83	1858	21.87	1871	41.69

Furnished by U. S. Weather Bureau, covering years 1871-1903.

MONTH.	MAXIMA.		MINIMA.		MEAN Ins.	Maxima in 24 Hours, Ins.
	Ins.	Year.	Ins.	Year.		
January	7.47	1890	0.33	1893	2.22	3.57
February	8.94	1882	0.43	1895	2.87	4.44
March	8.25	1897	0.40	1885	3.33	3.33
April	10.84	1893	0.46	1895	3.43	3.97
May	9.12	1896	0.95	1879	4.35	3.39
June	10.08	1875	1.12	1894	4.62	4.64
July	9.50	1875	0.37	1890	3.58	5.08
August	6.66	1888	0.07	1873	2.43	3.04
September	9.60	1886	0.01	1883	2.85	3.47
October	7.51	1885	0.23	1895	2.30	3.14
November	6.74	1881	0.89	1875	2.92	2.99
December	6.18	1884	0.18	1876	2.29	2.61
Annual	49.20	1898	23.38	1871	37.21	

Atmospheric Pressures and Velocities.

Atmospheric Pressures and Velocities.

1871-1903.

MONTH.	BAROMETER, INS.			WIND.				
					Maximum Velocity.			
	Highest.	Lowest.	Mean.	Prevailing Direction	Miles per Hr.	Direction.	Date.	Year.
Jan.	30.90	29.25	30.15	N. W.	66	S. W.	25	1898
Feb.	30.90	28.89	30.11	N. W.	59	S. W.	8	1900
March	30.70	29.07	30.03	N. W.	60	S. W.	11	1899
April	30.63	29.10	29.98	S. E.	54	S. W.	12	1893
May	30.41	29.27	29.95	S.	80	N. W.	27	1896
June	30.32	29.51	29.94	S.	61	W.	17	1882
July	30.32	29.57	29.96	S.	58	W.	24	1900
Aug.	30.39	29.60	29.98	S.	72	N. W.	4	1878
Sept.	30.48	29.42	30.03	S.	48	S. W.	11	1900
Oct.	30.60	29.45	30.06	S.	54	S.	23	1887
Nov.	30.78	29.24	30.11	S.	58	S. W.	21	1898
Dec.	30.93	29.31	30.14	N. W.	60	N. W.	4	1885

Julius Baier (Trans, Am. Soc. C. E., Vol. XXXVII) places the minimum barometric reading during the cyclone of May 27, 1896, at 27.23 inches. His computations show that the wind must have exerted a lifting pressure of at least 59 lbs. per square foot at the center of the Eads Bridge, and a static pressure of at least 60 lbs. per square foot at its east end. Also that the static pressure must have exceeded 85 lbs. per square foot at the corner of Missouri and Geyer Aves.

Local Forecaster Frankenfield reported that on the same occasion the wind blew 80 miles per hour or more for five minutes, reaching a maximum of 120.

The City Ordinances require buildings to be designed to resist a wind pressure of 30 lbs. per square foot.

The Mississippi River.

THE MISSISSIPPI RIVER

Stage.

Systematic observations of stage of river were inaugurated by the general Government in 1872, when a number of gauges were established. Others have been added and gauges are now to be found at intervals of about 50 miles. They are carefully connected by levels with substantial bench marks. Readings are taken twice each day, and the records are tabulated and published by the Mississippi River Commission, which has charge of this work.

The months of April, May, June and July are the best months for navigation, as the stage of the river is then materially above the normal, and a 12-foot channel depth from St. Louis southward can generally be expected. Low water conditions generally begin during the latter part of July and continue through the winter.

The St. Louis Gauge.

The St. Louis Gauge.

This is located near the foot of Walnut Street. Its zero coincides with the low water of 1863, and is 33.74 feet below the City Directrix, 378.99 feet above mean Gulf level, at Biloxi, Miss., by Mississippi River Commission line of precise levels, and 382.62 feet above mean ocean tide at Sandy Hook, by U. S. Coast Survey line of precise levels. O on this gauge indicates about 12 feet depth of water in the channel in the St. Louis Harbor, and about 4 feet in the shoal places between St. Louis and Cairo. Extreme stages were as follows:

Gauge.

Mississippi River Gauge.

Highest.			Lowest.		
Year.	Date.	Stage.	Year.	Date.	Stage.
1877	June 14	26 ft. 6 in.	1877	October 4	6 ft. 10 in.
1878	June 15	25 ft. 8 in.	1878	December 27	5 ft. 11 in.
1879	July 3	21 ft. 2 in.	1879	December 26	3 ft. 6 in.
1880	July 10, 11, 12	25 ft. 5 in.	1880	November 29	2 ft. 10 in.
1881	May 5	33 ft. 7 in.	1881	February 4, 5, 6	7 ft. 7 in.
1882	July 5	32 ft. 4 in.	1882	December 18	2 ft. 10 in.
1883	June 25	34 ft. 8 in.	1883	January 12	4 ft. 5 in.
1884	April 9	28 ft. 2 in.	1884	January 4	3 ft. 4 in.
1885	June 17	27 feet.	1885	December 16, 17	2 ft. 1 in.
1886	May 13	27 feet.	1886	December 4, 5	0 ft. 0 in.
1887	April 3	20.5 feet.	1887	December 26, 27	0.8 feet.
1888	June 3 and 4	29.3 feet.	1888	January 1	3.5 feet.
1889	June 1	24.4 feet.	1889	February 27	2.7 feet.
1890	June 30	20.7 feet.	1890	December 30, 31	2.8 feet.
1891	July 4	23.7 feet.	1891	December 6	2.3 feet.
1892	May 19	36.4 feet.	1892	December 27	0.2 feet.
1893	May 3	31.5 feet.	1893	December 9	0.0 feet.
1894	May 12	23.3 feet.	1894	February 3	0.2 feet.
1895	December 22	23.3 feet.	1895	January 2	0.5 feet.
1896	May 26	27.7 feet.	1896	December 11	3.8 feet.
1897	May 2	31.0 feet.	1897	December 24	0.3 feet.
1898	May 23	27.2 feet.	1898	December 11	0.4 feet.
1899	April 27	25.6 feet.	1899	February 1	0.7 feet.
1900	March 16	23.4 feet.	1900	January 2	-2.6 feet.
1901	April 18 and 19	22.4 feet.	1901	December 19	-1.3 feet.
1902	July 26	26.9 feet.	1902	January 30	-1.2 feet.
1903	June 10	38.0 feet.	1903	December 18	0.6 feet.

Average and Extreme Monthly Stages.

(1861-1903, inclusive.)

Average and Extreme Monthly Stages.

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Maximum,	24.8	28.2	25.7	31.5	36.0	38.0	32.2	29.8	22.2	25.1	29.5	23.4
Average.	7.4	9.2	13.9	18.3	18.9	19.3	17.9	11.8	9.3	8.5	8.1	6.3
Minimum,	-2.5	-0.5	0.3	5.8	5.6	7.2	6.6	3.7	2.3	2.4	2.1	-0.8

Contributed by J. A. Ockerson, from records of Mississippi River Commission.

The lowest stage reported is -2.6 feet in 1900, the highest 41.32 feet in 1844. Other notable high stages are: 1851, 36.54; 1858, 37.04; 1892, 36.4; and 1903, 38.0.

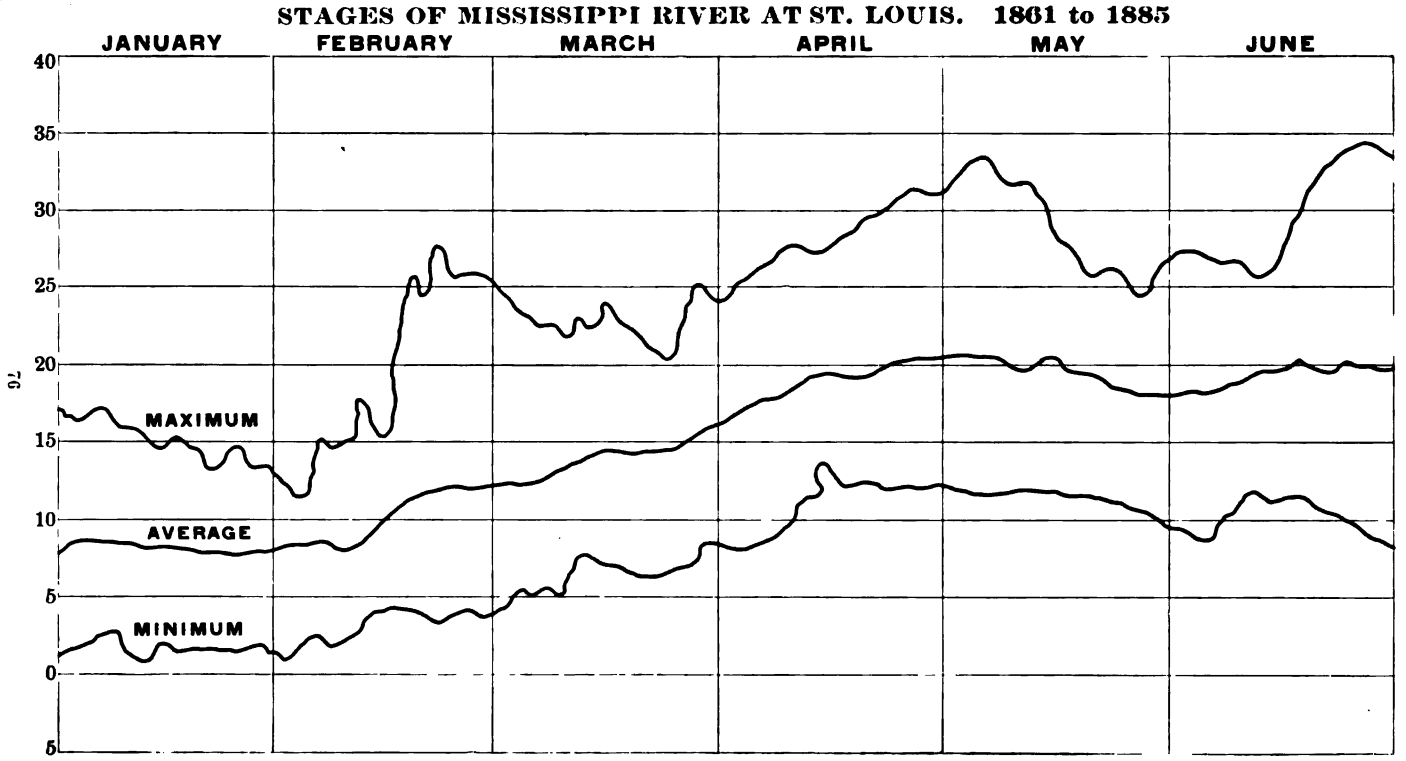
Maximum Rise and Fall at High Stages.

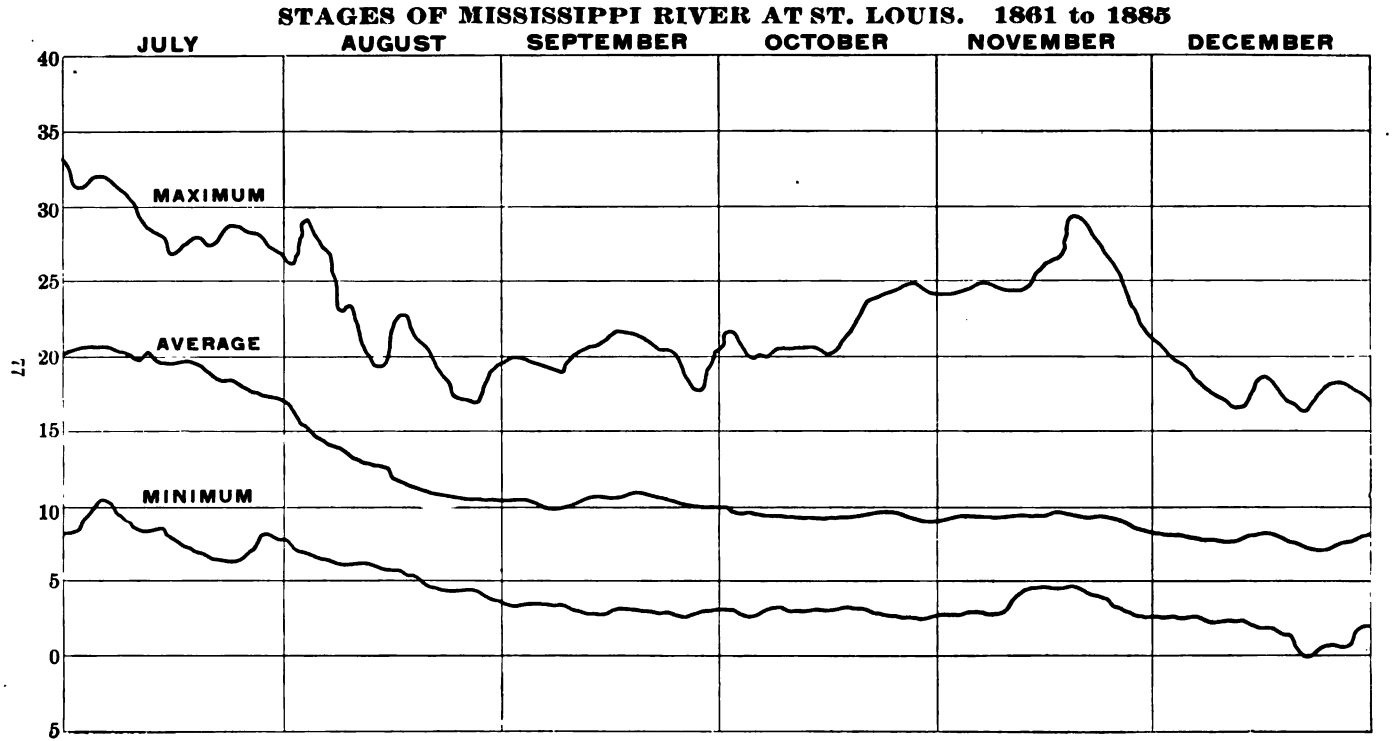
Maximum Rise and Fall at High Stages.

From Water Works records April, 1872, to April, 1885. Gauge located three miles above official gauge. Datum 100 feet below City Directrix.

GAUGE.	Rise in 24 hours, feet.	Fall in 24 hours, feet.	DATE.
92	...	4.2	August 8, 1875.
96	7.5	...	February 21, 1882.
98	3.5	...	August 2, 1875.
98	...	2.5	May 9, 1881.
99	3.2	...	May 8, 1876.
100	...	1.4	May 8, 1881.
101	2.0	...	May 9, 1876.
101	...	0.9	June 30, 1883.
102	0.9	...	June 20, 1883.
102	...	0.8	June 29, 1883.
103	...	0.5	June 27, 1883.
104	0.6	..	June 25, 1883.

Stages of Mississippi River at St. Louis. 1861 to 1885.





Stages of Mississippi River at St. Louis, 1861 to 1885.

Discharge and Velocity.

Discharge and Velocity.

Low water discharge at St. Louis reaches a maximum of 24,000 cubic feet per second, with a velocity of 1.4 feet per second. The discharge at high water in 1892 reached 1,146,000 cubic feet per second with a mean velocity of 12.1 feet per second.

Suspension of Navigation by Ice.

Suspension of Navigation by Ice.

For the past thirty-nine seasons navigation southward has been suspended by ice as follows:

Winter	1865-66, from Dec. 15th to Jan. 12th	27	days.
"	1866-67, from Dec. 26th to Feb. 3d	38	"
"	1867-68, from Jan. 8th to Feb. 18th	40	"
"	1868-69, open all winter.		
"	1869-70, from Dec. 21st to Dec. 28th	7	"
"	1870-71, from Dec. 21 to Jan. 23d	32	"
"	1871-72, from Dec. 1st to 18th and from Jan. 30 to Feb. 24	42	"
"	1872-73, from Nov. 29th to Jan. 20	51	"
"	1873-74, open all winter.		
"	1874-75, from Dec. 30th to Feb. 27th	58	"
"	1875-76, open all winter.		
"	1876-77, from Dec. 8th to Feb. 5th	58	"
"	1877-78, open all winter.		
"	1878-79, from Dec. 16 to Jan. 29th and from Feb. 14th to Feb. 17th	46	"
"	1879-80, from Dec. 17th to Dec. 31st, inclusive	15	"
"	1880-81, from Nov. 18th to Dec. 5th, and from Dec. 7th to 14th, and from Dec. 24th to Feb. 18th	78	"
"	1881-82, open all winter.		
"	1882-83, from Dec. 7th to 23d, and from Jan. 1st to Feb. 13th	59	"
"	1883-84, from Dec. 18th to Feb. 5th	48	"
"	1884-85, from Dec. 19th to 30th, and 35 days in Jan. and Feb.	47	"
"	1885-86, from Dec. 10th to Dec. 23d, and from Jan. 7th to Feb. 16th	55	"
"	1886-87, from Dec. 1st to Dec. 14th, and from Dec. 24th to Jan. 27th	49	"
"	1887-88, from Dec. 19th to Jan. 31st	43	"
"	1888-89, open all winter.		
"	1889-90, open all winter.		
"	1890-91, open all winter.		
"	1891-92, from Jan. 9th to Feb. 1st	23	"
"	1892-93, from Dec. 20th to Feb. 15th	57	"
"	1893-94, open all winter.		

Winter 1894-95, from Jan. 1st to Mar. 1st..... 59 days.
" 1895-96, open all winter.
" 1896-97, open all winter.
" 1897-98, open all winter, but some ice running.
" 1898-99, Dec. 7th to 22d, Jan. 1st to 10th, Jan. 30th to Mar. 1st..... 54 "
" 1899-00, Dec. 30th to Jan. 13th, and 24 days between Jan. 28th and Mar. 4th..... 37 "
" 1900-01, during February..... 28 "
" 1901-02, Dec. 15th to Jan. 15th, and from Jan. 25th to Feb. 28th..... 55 "
" 1902-03, Dec. 27th to Jan. 1st, and Feb. 16th to 23d 13 "
" 1903-04, from Dec. 8th to .....

Range 0 to 78 days; average 41.5 days per year.

Suspension of Navigation by Ice.

Slope.

Slope of Mississippi River.

Mr. J. A. Ockerson, of the Mississippi River Commission furnishes the following data covering slope of Mississippi River at ordinary low water, at and near St. Louis:

LOCATIONS.	SLOPE.		
	Miles	Ft. per Mile	Total.
Mouth of Missouri River to head of Chouteau Island.	3.0	.31	.93
Head of Chouteau Island to Chain of Rocks.....	4.0	.75	3.00
Chain of Rocks to Merchants Bridge (Bissell's Point)	7.0	.93	6.51
Merchants Bridge to Eads Bridge.....	3.5	.51	1.78
Eads Bridge to River Des Peres.....	8.5	.35	2.98
Total.....	26.0	.58	15.20

The table on page 80, furnished by Mr. Julius Pitzman, is interesting on account of the long reach covered, and as it brings out clearly the choking of discharge way at the Merchants' Bridge.

Table of the Maximum, Minimum and Average Temperatures (F) of River Water.

Table of the Maximum, Minimum and Average Temperature(F) of River Water.

From March, 1873, to July, 1878, inclusive.

Month.	Maxima.	Minima.	Average.
January	42	32	35.3
February	50	32	37.6
March	59	32	41.4
April	69	38	52.4
May	79	50	63.4
June	82	66	74.3
July	90	74	80.4
August	84	74	79.5
September	82	64	73.3
October	74	52	59.0
November	60	34	44.6
December	50	32	36.9

ELEVATIONS OF WATER SURFACE AT U. S. GAUGES BETWEEN ALTON AND CHESTER, ILL.

Zero Plane, 100 feet below Directrix of St. Louis.

Location of Gauges.	Distance between Stations in miles.	Zero stage, assuming it at 1.9 ft. below stage of Jan. 22, 1902.		10.4 ft. stage, Jan. 29, 1903.		20.1 ft. stage, July 19, 1903.		38 ft. stage, June 10, 1903.		Difference between high water of June, 1903, and Zero stage.	Average slope, Alton to Chester, feet per mile.		Elevations of high water if a plane is drawn from Alton to Waters Point.	Height of June flood, 1903, above what it should have been if the fall had been uniform from Alton to Waters Point.
			Slope, ft., per mile.		Slope, ft., per mile.		Slope, ft., per mile.		Slope, ft., per mile.		Low Water.	High Water.		
Alton		85.50		90.20		97.60		115.80		30.30			115.80	0.0
Chain of Rocks..	13.2	76.34	0.69	84.20	0.45	91.15	0.49	110.95	0.37	34.61			108.27	2.68
Bissell's Point...	6.9	67.22	1.32	77.90	0.91	87.40	0.54	107.80	0.46	40.58			104.33	3.47
Market Street...	3.7	66.26	0.26	76.66	0.33	86.36	0.28	104.26	0.96	38.00			102.23	2.03
Arsenal Street..	2.8	65.51	0.27	75.90	0.27	84.90	0.52	102.31	0.70	36.80			100.63	1.68
Barracks	7.5	63.27	0.30	73.10	0.37	81.20	0.50	96.77	0.74	33.50	0.64	0.594	96.35	0.42
(Kimmswick) Waters Point....	10.6	57.20	0.57	67.10	0.57	74.60	0.62	90.30	0.61	33.10			90.30	0.0
Cornice Rock....	9.9	50.95	0.63	61.95	0.52	69.65	0.50	85.45	0.49	34.50				
Little Rock, Mo.	22.6	36.75	0.63	46.6	0.68	54.00	0.69	69.30	0.71	32.55				
Chester, Ill.....	15.7	26.09	0.68	35.9	0.68	43.80	0.65	60.60	0.55	34.51				

Compiled by Julius Pitzman, Feb. 3, 1904.

Suspended Solids.

Suspended Solids.

From determinations by Wm. C. Teichmann, City Chemist.

Samples taken at Chain of Rocks. Observations extending from January, 1900, to June, 1901, inclusive.

Parts per Million by Weight.

Month.	Raw Water.		Subsided Water.	
	Missouri Shore.	Intake Tower.	Outlet Chamber.	Chemist's Office.
January	235	355	82	65
February	270	385	86	56
March	1,925	1,354	290	218
April	2,045	1,144	223	216
May	1,514	1,027	153	132
June	2,660	2,542	194	106
July	2,432	2,483	157	69
August	1,098	1,008	151	99
September	1,154	1,096	130	95
October	2,110	1,088	280	200
November	.....	.....	.....	.....
December	233	193	70	71
Averages	1,425	1,152	165	121

Maximum observation, 5.406, June 29, 1901; minimum, 40.
Maximum from City Chemists tap, 417; minimum, 20.

Chlorine, Grains per Gallon.

Chlorine, Grains per Gallon.

From the report of the Water Commissioner, April, 1887.

I. Sample from Bissell's Point.
II. " " Chain of Rocks, Missouri side.
III. " " Chain of Rocks, Illinois side.

	Average.			Maximum.			Minimum.		
	I	II	III	I	II	III	I	II	III
1886.									
March	0.56	0.43	0.24	0.76	0.84	0.30	0.41	0.27	0.22
April	0.53	0.33	0.20	0.70	0.62	0.27	0.43	0.19	0.16
May	0.50	0.29	0.17	0.62	0.54	0.27	0.32	0.16	0.16
June	0.60	0.48	0.33	0.78	0.92	0.49	0.46	0.32	0.16
July	0.53	0.53	0.38	0.70	0.70	0.52	0.47	0.38	0.27
August	0.87	0.87	0.50	1.40	1.46	0.58	0.70	0.58	0.41
September	1.15	0.99	0.44	1.52	1.11	0.55	0.93	0.87	0.41
October	1.16	0.95	0.39	1.46	1.22	0.47	0.99	0.82	0.35
November	1.16	1.06	0.38	1.34	1.28	0.50	1.05	0.87	0.29
December	1.25	1.58	0.60	1.76	2.51	0.70	1.17	1.17	0.47
1887.									
January	1.36	1.39	0.49	1.52	1.69	0.50	1.05	0.82	0.47
February	0.97	0.74	0.43	1.52	1.69	0.47	0.58	0.29	0.23
Yearly	0.89	0.80	0.38	....	....	....	....	....	....

Degree of Hardness.

Degree of Hardness.

Clark's Scale.

From report of Water Commissioner, year ending April, 1887.

I. Sample from Bissell's Point.
II. " " Chain of Rocks, Missouri side.
III. " " Chain of Rocks, Illinois side.

	Average.			Maximum.			Minimum.		
	I	II	III	I	II	III	I	II	III
1886.									
March	7.10	7.35	7.72	8.20	8.06	8.60	6.25	6.13	6.48
April	7.56	6.57	6.89	8.32	7.42	7.64	6.80	6.10	6.10
May	7.88	7.10	6.58	9.92	7.89	7.39	6.22	6.44	5.60
June	8.98	8.54	8.59	10.32	9.77	9.90	5.38	6.67	6.00
July	6.70	6.54	7.22	7.25	7.29	7.86	5.60	5.67	5.81
August	7.14	7.19	8.18	7.92	7.89	8.70	6.58	6.50	7.56
September	8.35	7.72	7.95	8.64	8.06	8.91	7.92	7.11	7.31
October	8.52	8.22	7.49	8.79	8.79	8.68	7.95	7.48	6.82
November	9.58	8.12	6.79	9.69	8.61	7.43	8.50	7.59	5.98
December	11.62	10.13	9.37	12.48	12.32	11.14	9.69	9.00	7.76
1887.									
January	11.23	11.41	8.92	12.26	12.80	8.99	10.64	9.52	8.77
February	8.70	7.03	5.98	11.04	11.01	8.68	5.83	4.62	4.95
Yearly	8*61	7.99	7.64	12.48	12.80	11.14	5.38	4.62	4.95

Analyses of Waters of Missouri and Mississippi Rivers.

Analyses of Waters of Missouri and Mississippi Rivers.

February 28, 1888.

From report of Water Commissioner, year ending April, 1888.

I. Mississippi River above Missouri.
II. Missouri River above mouth.
III. Chain of Rocks, Mississippi River.
IV. Bissell's Point, Mississippi River.

	I	II	III	IV	
Total solids	14.81	70.50	61.82	45.95	Grains per U. S. Gallons. 231 cubic inches.
Loss by ignition	5.25	11.37	15.86	9.85	
Filtered sediment	1.22	37.26	36.33	22.73	
Sulphuric acid	0.60	5.24	4.30	4.08	
Lime	3.09	6.43	6.40	5.54	
Magnesia	1.65	2.45	2.19	2.30	
Chlorine	0.31	1.14	0.83	0.93	
Iron and alumina	None	3.26	1.22	1.57	
Chloride of sodium	0.50	1.87	1.36	1.54	
Carbonate of lime	4.77	4.92	6.05	4.79	
Carbonate of magnesia	3.47	5.15	4.59	4.85	
Sulphate of lime	1.02	8.92	7.41	6.94	
Hardness	4°.24	8°.97	6°.48	6°.25	
Permanganate test	35.3	37.3	38.2	37.6	Parts per million by weight.
Free ammonia	0.02	0.005	0.01	0.01	
Albuminoid ammonia	0.15	0.18	0.12	0.06	
Nitrates	0.05	0.05	0.05	0.05	
Nitrites	None	None	None	None	

Sanitary Analyses.

Sanitary Analyses.

Average of daily determinations made from December, 1900, to June, 1901, inclusive, by Wm. C. Teichman, City Chemist.

I. From Missouri River at Bellefontaine.
II. " Mississippi River at Hartford.
III. " Mississippi River at Water Works Intake.
IV. " tap in office of City Chemist.

Parts per Million by Weight.

	I	II	III	IV
Total solids	1912.	549.	1556.	389.
Dissolved solids	296.	215.	254.	273.
Suspended solids	1336.	373.	1310.	114.
Nitrogen as total ammonia, unfiltered	1.284	0.845	1.101	0.367
" " " " filtered	0.363	0.472	0.347	0.271
" " free "	0.145	0.275	0.151	0.105
Albuminoid ammonia, total	1.129	0.613	0.958	0.274
" " dissolved	0.227	0.288	0.213	0.166
" " suspended	0.876	0.300	0.843	0.108
" " nitrites	0.007	0.018	0.087	0.009
" " nitrates	0.5	0.7	0.54	0.81
Oxygen consumed, unfiltered	18.3	12.2	17.36	6.9
" " filtered	4.3	8.2	6.1	5.2
Chlorine	16.	8.	13.	13.
Alkalinity	108.	119.	102.	140.

Bacteria.

Bacteria.

From tests made under the direction of Mr. George A. Johnson, from January 23d to April 30th, 1900. Abstracted from unpublished report.

Location at which samples were taken.	Number of Bacteria per cubic centimeter.			Bacteria Coli Communis.		
	Maximum Single Observation.	Ordinary Range of Maximum.	Ordinary Range of Minimum.	Number of Observations.	Number of Times Present.	Number of Times Absent.
Missouri River at Bellefontaine	821,000	400,000 to 500,000	30,000 to 50,000	89	33	56
Mississippi River at Hartford	486,500	200,000 to 300,000	10,000 to 20,000	88	40	48
Intake of St. Louis Water Works....	887,000	400,000 to 500,000	20,000 to 30,000	83	36	47
Settling Basin of St. Louis Water Works	499,000	200,000 to 300,000	5,000 to 10,000	88	36	52

Geology.*

Geology.

The geological formations exposed within the City limits are:

The **Loess**, or yellow or brick clays of Quaternary, or very recent age; thickness 10 to 40 feet.

*Data on Geology Coal Fields, Clay, Brick, Stones, and Sewer Tile, furnished by Mr. H. A. Wheeler.

Lower Coal Measures, consisting of a basal seam of bituminous coal 1 to 20 inches thick, resting on a basal fireclay bed 6 to 30 feet thick; a second higher seam of coal 20 to 50 inches thick, two to three thin beds of limestone and sandstone, and shales 20 to 70 feet thick; total thickness ranging from 0 to 250 feet.

Subcarboniferous Limestone, known as the "St. Louis," about 300 feet thick, which forms the river bluffs at Carondelet and is exposed in numerous quarries throughout the city. This limestone is very extensively utilized for macadam, building stone and fluxing for local consumption. Some of the beds are so pure that they erode through chemical action into sink-holes and underground drainage channels (caves) that were utilized as sewers in the early history of the city.

At the Insane Asylum, 3 miles south of the World's Fair, a well was drilled 3844 feet deep by the rod system, in 1866, that for many years was the deepest in the world. It passed through sedimentary formations, mostly limestones of subcarboniferous, Silurian and Cambrian ages, and undoubtedly would have reached the Archean granite in 200 feet or less.

At the Belcher Sugar Refinery, O'Fallon and First Sts., is an artesian well 2199 feet deep, drilled in 1849, from which flows a highly mineralized "sulphur" water that is used at the Belcher bath house.

Numerous wells have been drilled in St. Louis from 500 to 1500 feet deep at many of the factories and breweries, that usually yield plenty of clear water on pumping, though quite hard from lime salts.

A complete geological section of Eastern Missouri can be seen from the Iron Mountain R. R on going south 75 miles to Bismark. Although Bismark is 500 to 600 feet higher than St. Louis, the general dip is to the northeast, so the lower formations successively appear on going southward until the oldest known formations are found in the hills about Bismark or Archean granites and porphyries. Beginning with the Loess or Quarternary at Union Depot, this forms a mantle of yellow clay 10 to 30 feet thick as far south as Hematite (36 miles) where it feathers out. This is the source of raw material for the several red brick yards passed from 2 to 7 miles from the Union Depot. From Tower Grove (3 miles) to Carondelet Park (6 miles) occur lower coal measures (100 to 200 feet thick) that are utilized by several fire brick and sewer pipe plants in this vicinity. From Carondelet Park to Lower Kimswick (22 miles) are bold river bluffs 50 to 200 feet high of limestones of subcarboniferous age that are from 700 to 800 feet thick, and which are quarried at several places along the railroad for macadam, building stone, and for lime at Kimswick and Glen Park. Jeffer-

son Barracks (10 miles) is a large government post, and at 18 miles (Wickes) is the Meramec River, which occupies a fault and heads from a monster spring about 100 miles west. At Kimswick are sulphur springs, and fine mammoth and other large Quarternary remains are found 3 miles west. From Lower Kimswick to Pevely (27 miles) are 500 to 700 feet of Silurian limestones of Hudson River and Trenton age. From Pevely to Silica (32 miles) is a highly magnesian limestone known as the "first" magnesian, that is 150 to 200 feet thick. At Silica is the "first" or saccharoidal sandstone, soft, very pure sandstone that is used for glass-making at Crystal City (3 miles east) and about St. Louis; it is from 125 to 175 feet thick. From Pevely to Big River (48 miles, or 1 mile south of Vineland) is the "second" magnesian limestone, which contains limited deposits of lead and zinc that are worked on a small scale in Jefferson County near Hematite, DeSoto and Vineland. This formation is 500 to 600 feet thick and conspicuously faulted at the Iron Mountain R. R. tunnel at Vineland. At Big River is the "second" sandstone, which at this point is replaced by greenish shales. From Big River (48 miles) to Bismark (75 miles) is the "third" magnesian limestone, which is from 800 to 1000 feet thick. At Blackwell, Cadet, Mineral Point, and Potosi (3 miles west of Mineral Point by branch line) are numerous surface diggings or "gopher holes" after "tiff" or barite and heavy or "black" lead ore in the red surface clays. At Irondale (70 miles) is the Irondale Lead Mine (not working) on the western fringe of the great St. Francois County disseminated lead belt. At Bismark is the "third" sandstone (Cambrian) from 10 to 200 feet thick, which rests on Algonhian porphyries and Archean granites that form knobs and hills about Bismark, and which mark the eastern flanks of the Ozark Mountains. At Bismark take the Illinois Southern R. R. to Flat River (10 miles east), the heart of the disseminated lead district, where low-grade disseminated lead ore is worked on a large scale at the Doe Run, Central, Federal, Columbia, St. Joe (Crawley or No. 8 shaft), National and Desloge mines. (See cut, page 48.)

Coal Fields.

The St. Louis district is favored with the cheapest coal market in the country, with the possible exception of Pittsburg. This is due to a very regular cheaply mined 7-foot coal seam that outcrops along the Illinois bluffs of the Mississippi river opposite St. Louis. This seam is worked by about 50 mines within a 60-mile radius of St. Louis through shafts 50 to 350 feet deep. The mines are practically free from gas and water, the seam dips very greatly to the northeast, and the coal is mainly undercut by machines, the Harrison, Yoch, Ingersoll and Jeffrey

MADISON COAL COMPANY'S MINES.

cutters being employed. Capacity of mines vary from 200 to 2500 tons daily, and the wholesale price f. o. b. cars at East St. Louis range from $1.00 to $1.40 per ton for "run of mine." The coal is bituminous, occurs in the lower portion of the lower coal measures, and for analyses and fuel values see page 105. The western edge of this Illinois coal field feathers out in the basin that occurs in the western portion of St. Louis, from which the city was supplied until the exhaustion of the coal pits about 30 years ago. The site of the World's Fair was largely undermined 30 to 50 years ago by these old coal mines, and in grading for the Government Building at the eastern end of the grounds, a two-foot seam of coal (No. 2) was exposed. Some of the largest of the Illinois mines are at Staunton (38 miles) and Mt. Olive (43 miles) on the Wabash R. R. and at Divernon (83 miles), on the Illinois Central R. R. The Divernon mine (Madison Coal Co.) is one of the best equipped and has a daily capacity of 2000 tons; shaft is 370 feet deep, and uses electric underground haulage. (See cut, page 86.) Other large mines (2000 to 2500 tons capacity) are at Danville, Spring Valley, Springfield, LaSalle, Carterville and Murphysboro. At Marion is the No. 3 mine of the Southern Illinois Coal Co., operating a 10-foot seam, equipped with steel top works, a 1500-ton coal washer, and has a capacity of 2500 tons. At Decatur a 4-foot seam is worked, long wall, at a depth of 600 feet, and the deepest mine in Illinois is at Assumption, 1070 feet, and 700 feet at Pana.

Stone.

The St. Louis stone market is supplied by **limestone** quarries from St. Louis and vicinity.

Oolitic limestone, from the Bedford district, Indiana.

White limestone, or "marble," from Hannibal and Carthage, Missouri.

Limestone from Grafton and Joliet, Illinois.

Sandstone from Lake Superior, Colorado, and Warrensburg and St. Genevieve, Missouri.

Red and gray granite from southeastern Missouri.

Gray granites from Georgia and Maine.

Marbles from Kentucky, Vermont and Italy.

St. Louis District. There are numerous quarries in St. Louis, and from Alton, Ill. (22 miles north), Falling Springs, Ill. (18 miles east), and Wickes, Mo. (20 miles south), that furnish large quantities of macadam, rip-rap, foundation stone, and limited amount of dimension stone, that work over a vertical range of 300 feet in the subcarboniferous limestone formation. As the different beds in this formation vary greatly in composition, from very pure, non-flinty, non-magnesian beds, to very cherty (flint) highly magnesian beds, there is a great range in the

chemical composition, and also a very great range in the thickness of the beds. Most of the beds are more or less seamy and jointed with suture joints, so that they do not satisfactorily stand exposure, especially as powder is too freely used. Good, fairly durable, dimension stone can be secured from a few of the beds if proper care is taken in quarrying. Where not exposed, as in foundations, it is an excellent stone, as it has a high-crushing strength and is easily dressed. The St. Louis stone range through light to dark shades of gray.

Bedford Stone. This standard, well-known stone is now the principal dimension stone used in St. Louis, from its low cost, easy dressing and general excellence in resisting weathering, though there is considerable difference in the different beds, the deeper beds being more durable. The Bedford is an "Oolitic" limestone, or has a granular structure, and chemically is remarkably pure, analysing 96 to 98% carbonate of lime. The Bedford stone is gray in color, some being so dark as to be termed "blue."

Tests made on 3-inch cubes of Bedford stone by Prof. J. B. Johnson gave a crushing strength of 3140 to 3890 lbs. per square inch for the buff colored and 6090 for the "blue." Tests made of sawed beams gave:

Beams of Bedford Stone.

	Dimensions in inches.			Central Breaking Load in lbs.	Maximum Fibre Stress lbs. per sq. in.	Deflection in inches.	Resistance.	
							Inch. Total.	Lbs. Per cu. in.
	b	h	l	w	$f=\frac{3\,wl}{2\,bh^2}$	d	$\frac{1}{2}$ wd	
Blue	3.02″	4.0″	34.5	1200	1290	0.024	14.4	0.0346
Buff	3.02″	3.0″	42.	380	880	0.040	7.6	0.020

Hannibal and Carthage Stone. Both the Hannibal and Carthage stones occur in the subcarboniferous horizon, and both are very pure limestones that are exceptionally free from magnesia or chert. They are both used for making white lime, on account of their purity, and for dimension stone. As they range from very light gray to white in color they are capable of fine architectural effects, especially as they work freely, and are erroneously termed marbles. They are fairly durable, but are considerably troubled with suture joints that open upon weathering. The Hannibal quarries are more extensively used for lime, while the Carthage stone is shipped throughout the southwest for architectural purposes.

Analysis of Hannibal Limestone.

Specific gravity	2.533
Absorption	1.567%
Silica, Si O_2	0.07%
Ferric oxide and alumina, $Fe_2 O_3 + Al_2 O_3$	0.50
Lime, Ca O	55.20
Carbon dioxide, C O_2	43.37
Magnesia, Mg O	Trace.
Total	99.14

Grafton and Joliet Stones. The Grafton and Joliet districts in northern Illinois formerly shipped considerable dimension stone to St. Louis, but the cheaper and more durable Bedford stone has largely replaced it. Tests made for the Eads Bridge (in 1870) gave a crushing strength 12,300 lbs. per square inch, and a modulus of elasticity of 8,600,000, while Maine granite stood 11,700 to 16,400 lbs. and gave a modulus of 5,000,000 to 13,000,000. The following analyses by Mr. John Wixford are from samples used at the Chain of Rocks water works:

Analyses of Grafton and Joliet Stone.

	Grafton.	Joliet.
Lime, Ca O	29.44	33.52
Magnesia, Mg O	17.81	10.93
Carbon dioxide, C O_2	45.32	40.69
Alumina and ferric oxide, $Al_2 O_3 + F_2 O_3$	4.25	3.95
Sulphuric anhydride, S O_3	0.06	0.05
Silica, Si O_2	3.25	10.96
Organic matter and water	0.13	0.31
Total	100.26	100.41

Which show that they are dolomitic, impure limestones. The Grafton and Joliet stones range from yellow to gray in color.

Red sandstone is used in St. Louis for architectural purposes to a limited extent, that comes from the Portage Lake quarries of Lake Superior, and the Colorado quarries fronting the eastern face of the Rocky Mountains. They have a handsome red color, a fine grain, and are fairly durable, though there is quite a difference in the Colorado quarries and from different beds of the quarry.

Warrensburg and St. Genevieve Sandstone. The sandstone from Warrensburg and St. Genevieve, Missouri, is corse, and has not proved durable. It is very easily dressed and cheaply quarried, but is poor color (or a fawn to brown color) and lack of durability has resulted in its being replaced by Bedford limestone.

Missouri Granite. There are numerous and extensive quarries in Southeastern Missouri, in Madison, Iron, Wayne and St. Genevieve Counties that produce red to gray, hard, tough, dur-

Stone.

able stone that is known in the market as granite, though technically none of it is true granite. It makes a very durable, tough paving stone and a handsome dimension stone, though very expensive to dress. The spalls, or crushing, furnish the fine gravel or "ragging" for the better grade of granitoid flagging that is now the standard sidewalk in St. Louis (replacing brick).

Georgia and Maine gray granites reach the St. Louis market to a limited extent, the latter for monumental purposes on account of its sombre tone and great durability, and the former for building purposes from its less refractory nature in dressing.

The well-known marbles of Kentucky, Vermont and Italy are used in St. Louis for building and monumental purposes to a moderate extent.

Weathering of Stone.

Prof. J. L. Van Ornum furnishes the following representative data selected from more than fifty tests:

Kind of Stone.	Specific Gravity.	Percentage of Absorption (1 day).	Compressive strength in pounds per square inch.	Percentage of loss in 83% H_2SO_4 (1 week).	Loss in parts per 1,000,000 from freezing, 10 Times.	20 Times.	30 Times.
Oolitic limestone (St. Louis group)...	2.7	0.4	17,700	0.8	632	1,030	Shattered.
St. Louis limestone (hard, blue).....	2.7	0.7	15,300	7.9	12,780	Shattered.	.....
St. Louis limestone (gray)	2.4	0.7	7,100	12.4	3,010	4,810	5,730
Union sandstone (oolitic limestone)..	2.6	3.2	4,000	2.1	5,110	Shattered.	.....
Meramec oolitic limestone	2.6	1.6	9,000	12.7	2,140	5,090	11,040
Bedford limestone (buff)	2.4	1.6	4,400	1.4	710	2,180	5,100
Bedford limestone (blue)	2.6	2.9	7,900	3.8	1,820	4,090	8,280
Carthage limestone...	2.7	0.6	5,600	.....	1,130	3,290	Shattered.

Building Brick.

Building Brick.

St. Louis is covered with a 10 to 40-foot mantle of Loess or yellow clay that is free from gravel, remarkably uniform, and which makes a superior building brick of fine red color by either the soft mud or dry press process. The latter system of modern brick-making originated and has been perfected in St. Louis. The test of 40 years service in the severe sulphurous climate of St. Louis shows that dry press brick, if properly made, are as

durable as any other well burned clay product, which is equivalent to saying that they exceed most if not all building stones in resisting the destructive action of the weather, for granite, sandstones, limestones, marbles and slates have proved less durable in St. Louis. Formerly the soft mud process was employed, both hand and machine, but the large modern yards all use the dry press process. (For location of brick yards see pages 50 and 51.)

Building Brick.

The chemical and physical properties of this Loess yellow brick clay range as follows:

Silica, 72 to 78%.
Alumina, 10 to 13%.
Oxide of iron, 3 to 5%.
Lime, 1 to 2%.
Magnesia, 0.5 to 1.5%.
Alkalies, 3.0 to 3.5%.
Combined water, 3 to 7%.
Specific gravity, 1.98 to 2.20.
Tensile strength, 100 to 200 lbs. per square inch.
Shrinkage, in drying from a stiff mud, 4.5 to 5.7%.
Shrinkage, when hard burned, 4 to 6%.
Incipient vitrification begins at 1800° to 2000° F.
Complete vitrification begins at 2000° to 2200° F.
Deformation begins at 2100° to 2300° F.

The following table gives the density and absorption of red brick made by the soft mud or hand process, and by the semi-dry process as made by the hammer and press machines. The brick are numbered in the order of their hardness, as shown by the sound of the brick when struck, No. 1 being the softest or salmon, and No. 26 the hardest:

Red Brick.

RED BRICK.

Density and Absorption.

Number.	Specific Gravity.	Wt. per cu. ft.	Per cent. of water absorbed.	Kind of brick.	Number.	Specific Gravity.	Wt. per cu. ft.	Per cent. of water absorbed.	Kind of brick.
1	1.49	93.1	21.3	Hand.	14	1.98	123.7	8.5	Hammer.
2	1.61	100.6	21.0	Pressed.	15	1.68	105.0	15.8	Hand.
3	1.83	114.4	14.1	"	16	1.91	119.4	11.3	Pressed.
4	1.79	111.9	15.3	"	17	1.69	105.6	15.0	Hand.
5	1.83	114.4	13.5	"	18	1.83	114.4	13.0	Pressed.
6	1.54	96.3	20.0	Hand.	19	1.96	122.5	9.4	"
7	1.69	105.6	18.1	Pressed.	20	1.88	117.5	12.3	"
8	1.72	107.5	17.1	"	21	1.82	113.8	13.3	"
9	1.72	107.5	14.2	Hand.	22	1.93	120.6	9.2	"
10	1.81	113.1	14.8	Pressed.	23	1.85	115.6	13.0	"
11	1.86	116.2	12.3	"	24	2.01	125.6	8.2	Hammer.
12	1.96	122.5	9.6	Hammer.	25	1.88	117.5	11.0	Pressed.
13	1.85	115.6	12.4	"	26	2.18	136.3	4.7	"

Size and Weights of St. Louis Brick.

Size and Weights of St. Louis Brick.

By measurements of twelve brick of each kind from four different yards.

Kind of Brick.	Length.			Width.			Thickness.			Specific Gravity.	
	Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.	Maximum.	Minimum.
Paving	8 3/8	8	8 3-16	4 1/4	3 7/8	4	2 5-16	2 1-16	2 1/8	2.18	1.95
Dark red	8 1/2	8 1/4	8 5-16	4 1/4	4	4 1/8	2 3/8	2 1/8	2 3-16	1.95	1.80
Light red	8 1/2	8 3/8	8 7-16	4 1/4	4	4 3-16	2 3/8	2 1/8	2 1/4	1.80	1.65
Salmon	8 5/8	8 3/8	8 1/2	4 3/8	4 3-16	4 1/4	2 1/2	2 1/4	2 5-16	1.65	1.48

St. Louis building brick gave a crushing strength of 2000 to 7500 pounds per square inch in tests made for the Eads Bridge, or have an excess of strength for ordinary buildings.

Stock brick closely piled measure about 51 cubic feet per 1000, and common brick 52 to 54 cubic feet.

The St. Louis market grades building brick into:

Merchantable (usually equivalent to "kiln-run"), which includes one-third salmon or backing-up brick, one third "straight hard" for facing and one-third "rough hards" (or light reds) for foundations, etc. This grade is used on dwellings and smaller buildings, and usually sells delivered at job for $5 to $7 per M.

Salmon are soft, or underburned brick, that are only fit for backing-up, as they will not withstand frost; usually sell for $3.50 to $5 per M.

Straight hard are hard burned true brick, suitable for engineering or heavy construction, or outside work. They usually sell for $6 to $9 per M.

Rough hards are warped or flashed or blackened brick that are used for foundations, sewers, etc.

Paving are very hard true brick that are used for sidewalks, and sell for $8 to $11 per M.

Stock or face brick are well-burned, carefully made, uniformally colored brick that have uninjured corners and edges, and are not flashed. They shade from No. 3 to No. 8 in color, the latter being the darkest. They are also one-eighth inch thicker than common brick. They sell for $9 to $14 per M.

Roman brick are stock brick that lay up 12 inches in length.

Standard brick lay up 8 inches in length.

Buff, grays, etc., are stock brick made from fireclay that has been more or less colored by metallic oxides.

Enamel brick has a fireclay body on which a face of colored glass (glaze or enamel) is burned. In the St. Louis climate

enamel brick will not stand outside exposure without crazing (hair cracks) from the difference in expansion between the dense glass surface and the porus body.

Safe Loading on Brick Work.

Safe Loading on Brick Work.

The City Building Ordinances permit the following loadings for good brick work:

When good lime mortar is used..... 8 tons per superficial foot.
" " " and cement is used....11.5 " " " "
" Portland cement is used.....15 " " " "

Vitrified Brick.

Vitrified Brick.

Vitrified brick are made at seven plants in and about St. Louis for street paving, sewers, foundations, etc. They are made in "standard" (8¼-inch by 4-inch by 2½-inch) and "block" (9-inch by 4-inch by 3-inch) sizes from shales that occur in the lower coal measures, by the stiff mud (auger machines) and semi-dry (press at Glen Carbon) processes. These shale beds range 20 to 70 feet in thickness and are quarried with steam shovels and by blasting.

The chemical and physical analyses of these shales range as follows:

Silica, 54 to 61%.
Alumina, 18 to 24%.
Combined water, 6 to 8%.
Moisture, 0 to 4%.
Iron sesquioxide, 6 to 8%.
Lime, 0.5 to 3%.
Magnesia, 0.1 to 1%.
Alkalies, 3 to 4%.
Specific gravity, 2.32 to 2.42.
Tensile strength, 105 to 175 lbs. per square inch.
Shrinkage in drying from a stiff mud, 5 to 8%.
Shrinkage in burning dried bricklets (hard burned), 6 to 8%.
Total shrinkage, 13 to 16%.
Incipient vitrification occurs at 1700° to 1800° F.
Complete vitrification occurs at 1900° to 2000° F.
Deformation occurs at 2100° to 2200° F.

St. Louis vitrified brick have a low absorption or from 0.8 to 3.0% on 24 hours soaking, and have a specific gravity of 2.25 to 2.40. They have a cross breaking strength of 2,000 to 4,000 lbs. per square inch, and a crushing strength of 12,000 to 20,000 per square inch.

Firebrick and Refractories.

Firebrick and Refractories.

The western part of St. Louis, including the World's Fair grounds, is underlaid with a superior bed of fireclay that ranges from 5 to 30 feet in thickness, and averages 6 to 7 feet of good clay. While the clay varies more or less in quality as well as thickness, it is coarse grained very plastic, and usually has a high tensile strength. It contains more or less iron pyrites

("shiners"), that usually occurs as very fine disseminated crystals, but occasionally as coarse nodules, and which forms black spots when it is hard burned. This fireclay is very extensively utilized at ten factories in St. Louis for firebrick, gas retort, sewer pipe, buff and enamel brick, etc. When selected from the better grade it makes such a superior long-lived zinc retort that it is shipped to all the zinc smelters throughout this country. This is also true of St. Louis gas retorts. Occasionally purer parts of the seam are sorted out into glass-pot clay, both crude and washed, which is shipped to glass works throughout this country, and is the only important competitor of the imported German pot clay.

Firebrick is made in St. Louis by hand or soft-mud, stiff-mud, semi-dry and dry-press processes, and sell from $12 to $30 per M, according to grade and brand. They average 2½ by 4⅜ by 8⅞ inches and weigh about 7 pounds, or 121 pounds per cubic foot.

The chemical and physical properties of the St. Louis fireclay range as follows:

Silica, 54 to 64%.
Alumina, 20 to 31%.
Combined water, 8 to 13%.
Moisture, 0 to 3%.
Ferric oxide, 2.6 to 5%.
Lime, 0.5 to 2%.
Magnesia, 0.1 to 0.9%.
Alkalies, 0.5 to 1.3.
Titanic acid, 0.9 to 1.6.
Sulphur, 0.3 to 1.5.
Specific gravity, 2.4 to 2.45.
Tensile strength, 80 to 140 lbs.
Shrinkage in drying from a stiff mud, 6 to 8%.
Shrinkage in hard burning dry bricklets, 4.5 to 7%.
Total shrinkage, 11 to 15%.
Incipient vitrification begins at 2100° to 2250° F.
Complete vitrification begins at 2300° to 2450° F.
Deformation begins at 2500° to 2700° F.

The St. Louis fireclay is popularly stated to withstand 3000° to 5000° F. from the erroneous ideas still inherited by most firebrick and furnace people from the unreliable pioneer determinations (and guesses) still extant in a few unrevised books. The highest heats attainable in fuel furnace practice range from 2500° to 2800°, and steel furnaces range from 2300° to 2600° F.

Flint fireclays: In numerous pockets or old sink-holes in lower Silurian limestone in Central Missouri occurs a remarkably pure non-plastic fireclay known as "flint" clay. These clays are absolutely refractory in fuel furnace heats, and are extensively shipped to the St. Louis firebrick works to produce a very superior, highly refractory firebrick when mixed with some

St. Louis fireclay for bonding. The chemical and physical properties of these Missouri flint clays range as follows:

Firebrick and Refractories.

Silica, 41 to 48%.
Alumina, 37 to 43%.
Combined water, 13 to 15%.
Moisture, 0 to 1%.
Ferric oxide, 0.3 to 1.5%.
Lime, 0.3 to 1.5.
Magnesia, 0.1 to 0.4.
Alkalies, 0.2 to 1.2.
The average amount of fluxing impurities ranges from 2 to 3%.
Specific gravity, 2.39 to 2.45.
Tensile strength, 15 to 40 lbs.
Shrinkage in drying from a stiff paste, 3 to 4%.
Shrinkage of dried bricklets when hard burned, 8 to 12%.
Total shrinkage, 12 to 16%.
Incipient vitrification occurs at 2300° F.
Complete vitrification occurs at 2500° F.
Deformation occurs above 2700° F.

Sewer Pipe.

Sewer Pipe.

Sewer pipe is made at three large factories (2 pipe presses each) in St. Louis from a mixture of fireclay, Loess or brick clay, and occasionaly some shale. This mixture makes a good, tough dark pipe that is exceptionally straight and free from blisters and cinder cores, and enables the largest sizes, or up to 36 inches in diameter, to be made with safety. In fact these large St. Louis pipe have such a favorable reputation that they are shipped past the Ohio shale sewer pipe shops to the New England markets, where they are largely replacing brick.

Tests made at Rose Polytechnic Institute with hydraulic pressure gave an average tensile strength of 600 lbs. per square inch.

The following tests give the absorption of St. Louis pipe:

Absorption of Salt Glazed Sewer Pipe.

Absorption of Salt Glazed Sewer Pipe.

Color of Fracture.	Specific Gravity.	Per cent of absorption by weight when immersed in water. 24 hours.	72 hours.	96 hours.
Dark	2.14	3.27	3.74	3.74
Light	2.19	2.91	2.91	2.91

Sewer pipe grade into "single strength" or standard "double strength," in which the thickness is 1-12 the diameter, and "seconds," or damaged pipe, that sell at a heavy discount.

The manufacturer's price list given below contains useful information in regard to sewer pipe as made in this city. The discounts for standard pipe range from 70 to 90%:

Standard Salt Glazed Sewer Pipe.

Standard Salt Glazed Sewer Pipe.

Inside Diameter.	Straight Pipe, per foot.	Curves and Elbows, each.	T & Y Junctions, each.	Weight per foot.	Area in inches.	No. of feet in Car Load of 12 tons.	Inside Diameter.	Straight Pipe, per foot.	Curves and Elbows, each.	T & Y Junctions, each.	Weight per foot.	Area in inches.	No. of feet in Car Load of 12 tons.
In				Lbs.			In.				Lbs.		
3	$0 15	$0 50	$0 60	7	7	3430	14	$0 90	$3 25	$3 60	52	154	460
4	20	60	80	9	12	2660	15	1 00	3 75	4 00	57	177	420
5	25	75	1 00	12	19	2000	16	1 20	4 25	4 80	66	201	364
6	30	1 00	1 20	16	28	1500	18	1 50	4 75	6 00	82	254	290
7	35	1 25	1 40	19	39	1260	20	1 75	5 75	7 00	94	314	254
8	40	1 50	1 60	23	50	1040	21	1 90	6 25	7 60	100	345	240
9	50	1 75	2 00	28	64	860	22	2 10	7 00	8 40	110	380	218
10	60	2 10	2 40	33	78	730	24	2 50	8 00	10 00	130	452	180
12	75	2 75	3 00	42	113	570							

Terra Cotta.

Terra Cotta.

Terra Cotta for architecutral purposes is manufactured in considerable quantities in and near St. Louis.

The following are the results of crushing tests on four two-inch cubes of red terra cotta, made by the Winkle Terra Cotta Co. of St. Louis. Plaster of Paris used for bearing surfaces:

	Area, square inch.	Total load.	Load per square inch.
1	4.14	6,600 lbs.	1,590 lbs.
2	4.39	8,240 "	1,880 "
3	4.02	10,530 "	2,620 "
4	4.16	6,370 "	1,530 "
		Average,	1,905 "

Sand.

Sand.

The greater part of the sand used in St. Louis is from the channel and bars of the Mississippi River. This sand weighs 105 lbs. per cubic foot, and contains about 30% of voids. Sand settled by sprinkling in water weighs 112 lbs. per cubic foot, after deducting the weight of water in voids, i. e., 112 lbs. of dry sand sprinkled into water will occupy one cubic foot of space. The specific gravity of the average particle is 2.60.

Three parts of sand and one part of Louisville cement will give three parts of mortar. Two and one-half parts of sand and one part of Puzzolan cement (fine ground) will give two and one-half parts of mortar. Any additional cement in either case will give an increased volume of mortar.

The experiments given below show the value of river sand for mortar. The tests were made with Dyckerhoff cement mixed with a sample of standard sand, such as is used in the official

testing laboratories of Germany, and also with Mississippi River sand; mixture, one part by weight of cement to three of clean coarse sand:

Sand.

KIND OF SAND.	No. of samples.	Age—days.	Tensile strength, lbs. per sq. in.	No. of samples.	Age—days.	Tensile strength, lbs. per sq. in.
German Standard	5	7	182	5	28	220
Mississippi River	10	7	249	10	28	257
Kaw River	....	....	.....	3	7	218
Bar opposite city	....	....	.....	3	7	184
Meramec River	....	....	.....	3	7	197
German Standard	....	....	.....	3	7	208
Mississippi (passing a No. 20 but not a No. 30 sieve)	....	....	.....	3	7	225

Cement.

Cement.

The only strictly local cement is that made by the St. Louis Portland Cement Co. (See description of their plant on page 43.)

This company reports the following analysis of the raw material used in this cement, which is known as the "Red Ring" brand:

Analysis of Limestone.

Analysis of Limestone.

$Ca\ C\ O_3$	98.50
$Mg\ C\ O_3$	.20
$Si\ O_2$	.75
$H_2\ O$ and alkalies, by difference	.20

Analyses of Clay.

Analyses of Clay.

	Loess.	Upper Shale.	Lower Shale.
Loss	5.10	4.50	5.65
Silica	71.00	62.85	53.10
Alumina	15.44	22.10	27.30
Oxide of iron	4.25	4.65	5.25
Lime	.75	.70	1.15
Magnesia	1.70	2.10	3.10
Sulphuric anhydride	.20	.45	.95
Alkalies, by difference	1.56	2.65	3.50

This cement was tested by Prof. J. L. Van Ornum at the Washington University Laboratory, with the following results:

Fineness, passed through 100-mesh sieve.....96.0%.
Initial set .....1½ hours.
Final set .....3 "
Soundness: Pats and balls showed no cracks or disintegration in 4 hours' boil in water and steam.

Tensile Strength—Neat.

24 hours in air	242	288	275
1 day in air, 3 days in water	744	838	792
1 day in air, 6 days in water	790	800	806
1 day in air, 13 days in water	915	882	832
1 day in air, 27 days in water	876	876	888

Analysis of Clay.

One Cement to Three of Sand.

24 hours in air.....	114	101	124
1 day in air, 3 days in water.....	204	220	218
1 day in air, 6 days in water.....	244	272	242
1 day in air, 13 days in water.....	283	275	288
1 day in air, 27 days in water.....	300	331	277

Strength of Various Kinds of Timber.

Average Ultimate Strength of Various Kinds of Timber, with Average Factor of Safety to be Used.

Prof. J. L. Van Ornum furnishes the following data regarding the various woods used regularly in St. Louis:

	Tension.		Compression.		Shear.		Transverse.	
	With Grain.	Across Grain.	With Grain.	Across Grain.	With Grain.	Across Grain.	Modulus of Rupture.	Modulus of Elasticity.
Factor of Safety.....	10	10	5	4	4	4	6	
1. Yellow Pine (long leaf).....	12,000	600	8,000	1,400	800	5,000	10,000	2,000,000
2. Yellow Pine (short leaf).....	9,000	500	6,000	1,000	700	4,000	9,000	1,600,000
3. White Pine.....	7,000	500	5,500	800	400	2,000	8,000	1,400,000
4. White Oak.....	10,000	2,000	8,500	2,200	1,000	4,000	12,000	2,000,000
5. Red Oak.....	9,000	.....	8,000	2,300	1,100	.....	11,000	2,000,000
6. Water Oak.....	.....	.....	7,800	2,000	1,100	.....	12,000	2,000,000
7. Shagbark Hickory	.....	.....	9,500	2,700	1,100	.....	16,000	2,400,000
8. Water Hickory....	.....	.....	8,400	2,400	1,000	.....	12,000	2,000,000
9. Pignut Hickory...	.....	.....	10,000	3,200	1,200	.....	18,000	2,700,000
10. White Elm.....	.....	.....	7,000	1,200	800	.....	10,000	1,500,000
11. White Ash.....	.....	.....	7,200	1,900	1,100	.....	10,000	1,600,000
12. Sweet Gum.....	.....	.....	7,000	1,400	800	.....	9,000	1,700,000
13. Redwood	7,000	.....	6,000	800	400	.....	4,500	700,000
14. Spruce	8,000	500	6,000	700	400	3,000	4,000	1,200,000
15. Hemlock	6,000	.....	6,000	600	350	2,500	3,500	900,000
16. Cypress	6,000	.....	6,000	700	.....	.....	5,000	900,000
17. Cedar	8,000	.....	6,000	700	.....	1,500	5,000	700,000
18. Chestnut	9,000	.....	6,000	900	600	1,500	5,000	1,000,000

This table is for well-seasoned lumber, or timber having about 10 per cent of moisture only; green or wet timber has only about half the strength of seasoned timber. With such a variable material as wood, individual tests differ considerably; the field of variation in results of tests of first-class woods being from 20 to 40 per cent of the average values given in the table

Timber in Railway Service.

Timber in Railway Service.

The following data, obtained from Mr. C. D. Purdon, are from the territory covered by the St. Louis & San Francisco Railroad Co., and are quoted from the experience of the following officers of that company: Messrs. G. W. Turner and A. S. Blodgett, Superintendents of Bridges; Messrs. S. S. Sampson and A. Q. Campbell, General Road Masters.

Timber in Railway Service.

While white oak and post oak have been most generally used for ties, some other oaks have also been employed. Experience with all of them is given in table below. Spanish or willow oak, and red oak, are not generally used for ties.

A number of long leaf pine ties from Georgia were laid 17 years ago in Alabama. About 16% are still in service and apparently perfectly good.

For piling, oak is generally used. Experience shows that oak cut in the winter and allowed to season before driving, will last from two to three years longer than that cut in the summer. Cedar piles last well, but are not satisfactory for the reason that they are difficult to drive in hard ground, breaking to pieces under the hammer.

For bridge timbers white oak caps have been used, but long-leaf pine is now employed for caps, stringers and ties, and lasts from 8 to 9 years.

Life of Timber.

Life of Timber.

Ties.

White oak	6 to 8 years.
Post oak	6 " 7 "
Chestnut oak	6 " 7 "
Mountain oak	6 " 7 "
Spanish or willow oak	4 " 5 "
Red oak	3 "
Long leaf pine	17 years or more.

Piling.

White oak	8 years.
Red cypress	10 "
White cypress	4 "
Red cedar	12 "

Bridge Timbers.

White oak caps	5 years.
Long leaf pine stringers and ties	8 to 9 "

Timber in City Service.

Timber in City Service.

The experience of the City Bridge Department has been, in the case of bridge floors, that when the timber is subjected to wear by heavy traffic, oak will last about twice as long as white pine, but where there is no wear the pine will last about as long as the oak. In the bridges of Forest Park, yellow pine has not lasted as well as white pine.

On tne Duncan avenue bridge, over the Wabash R. R. tracks, yellow pine joists were found to be perfectly sound after sixteen years. It is supposed that the drying effect of the smoke from the locomotives preserved them from decay.

On the floor of the Jefferson Avenue bridge sawed gum blocks lasted eight years, but gave trouble by swelling.

On the Eighteenth Street Bridge sawed white pine blocks were gone in five years. Some of these blocks were originally

Timber in City Service.

treated with chloride of zinc, but these lasted no better than the untreated.

The bridge was again paved with white pine blocks, and after one year they were rotting badly.

On the Grand Avenue bridge, white pine blocks, untreated, lasted three years.

Under the rails of the incline of the temporary pumping plant of the waterworks, yellow pine ties and stringers were badly decayed in five years. These timbers were embedded in cinders and submerged at high water. The timbers at the lower end of the incline, which were embedded in mud, were still sound.

Steam Boilers.

Steam Boilers.

The City records show that there are 1132 boiler plants in St. Louis, containing 2041 boilers, aggregating 249,512 rated horse power. These are mostly horizontal return tubular boilers, with 4 or 6-inch tubes, and external brick settings. Among the larger and more modern plants the water-tube boiler with external setting is found. There are a few return flue, a few internally fired, and a few vertical boilers. The local conditions affecting boiler design are the sediment in the water, and the soot and ash in the fuel.

Efficiency of Boilers.

Efficiency of Boilers.

The following table, compiled from the results of over 150 evaporative trials made by Mr. William H. Bryan, give the efficiencies of steam boilers in this vicinity, as measured by the heat units in the steam delivered, compared with that existing in the coal as burned:

KIND OF BOILERS.	Number of Trials.	EFFICIENCY—PER CENT.		
		Maximum.	Minimum.	Average.
Small vertical	3	46.10	34.60	41.60
Large "	3	52.30	49.00	50.90
" " improved settings	1	One trial only.		67.89
Tubular boilers	15	60.17	44.76	51.69
" improved settings	37	76.38	41.94	59.20
Water tubular	33	70.11	41.96	60.03
" improved settings	30	81.32	49.30	65.00

Smoke Abatement.

Smoke Abatement.

For 10 years St. Louis has been active in smoke abatement, and has led the work among municipalities in this country. The movement was inaugurated by the Engineers' Club of St. Louis, and was later taken up by the Citizens' Smoke Abatement

Association, and is now in the hands of the Civic Improvement League. This effort resulted in the adoption of State and Municipal laws, declaring the emission of dense smoke a public nuisance and providing for the enforcement of the ordinances by a Chief Smoke Inspector and five deputies. Various kinds of apparatus have been successfully employed, as follows, in the order of their efficiency: Down-draft furnaces, automatic stokers, firebrick arch furnaces, and steam and air jets.

Smoke Abatement.

The City reports that, of the 1132 boiler plants, 859 use smoke preventing devices, divided as follows:

570, or 66%, using steam jet and air blast devices;
196, " 23%, using down draft furnaces;
37, " 4½%, using fire brick arches;
32, " 3½%, have changed from steam to electricity;
12, " 1½%, use automatic stokers;
12, " 1½%, use smokeless fuels.

In addition, 273 plants, mostly small or heating plants, have no special devices, but are making satisfactory smoke records by reason of good common settings and skillful firing.

Mr. Wm. H. Bryan submits the following data on results of 53 boiler trials on which careful records were kept of the smoke:

KIND OF FURNACE.	Number of trials.	Smoke Emitted—Per Cent.		
		Maximum.	Minimum.	Average.
Common furnace.....	9	75.42	11.09	40.61
Improved "	44	43.40	.29	9.29

The data from common furnaces represent them just as they were being operated in regular service. Those from the improved settings represent good, bad and indifferent devices.

Of forty-four trials of improved, or so-called "smokeless" furnaces, during which careful records were kept of the smoke:

9	averaged	less than.....	1		per cent.
11	"	between	1	and 5	"
11	"	"	5	" 10	"
7	"	" 10		" 20	"
6	"	above 20			"

Instructions for Firing Common Illinois Coals with Minimum Smoke.

Firing Illinois Coals.

Fire frequently and in small quantities. Break up the lumps to first size. Carry a level fire over the entire grate surface, not too thick. Avoid thin or bare spots. Keep the fires clean.

Firing Illinois Coals.

Fire one door at a time, and wait until that fire is in good shape before charging the other door. Keep the time intervals between firings as nearly uniform as possible.

Fire not over three shovels per door to begin with. If this makes no serious smoke, increase to four shovels, and then to five or six shovels until the smoke from the chimney shows that the limit has been reached.

Immediately after each firing leave the fire door slightly ajar for three or four minutes, thus admitting a little fresh air above the bed of fuel.

Coal Consumed in Heating Buildings.

Coal Consumed in Heating Buildings.

The local conditions affecting this matter are climate and quality of fuel, both of which are fully treated of elsewhere herein—see index. The climate may be called moderate, neither extremely cold nor extremely warm. The fuel, however, is of low grade.

Heating by Steam.

Heating by Steam.

Col. E. D. Meier gives, in the 1893 edition of this data, the following figures covering three first-class buildings of average location and exposure:

Bldg.	Cubical Contents.	Lbs. Coal per hour per 1000 cu. ft. contents.	Lbs. Coal per hour per 1000 sq. ft. exposure.	Tons per year per 1000 cu. ft.*
A	750,000	0.310	6.30	.56
B	650,000	0.423	9.49	.76
C	3,228,000	0.317	10.24	.57

A. C. Edgar ("Heating and Ventilation," July, 1900) computes the average amount of coal required per season in St. Louis, per square foot of steam radiating surface, as 39.17 lbs. This is based on average temperature, on coal delivering 10,000 B. T. U. per lb., and an output of 284 B. T. U. per square foot of surface per hour. As our common Illinois coals will deliver only about 6667 B. T. U. per lb. this figure should be about 60 lbs. instead of 39.17.

The Board of Education Building, northwest corner 9th and Locust Sts., consumed for heating alone, in 1896, 750 tons of common coal, and in 1897, 800. Its contents being about 2,000,000 cubic feet, the consumption per 1000 cubic feet per season is approximately .40 tons. This was distributed throughout the year as follows:

*Computed by the Editors on an assumed service of 3,600 hours annually. The ton used herein is always the "short" ton, of 2,000 lbs.

January	158	tons.
February	139	"
March	116	"
April	54	"
May	14	"
June, July, August and September		
October	51	"
November	92	"
December	147	"
Total	771	"

Heating by Steam.

Heating by Hot Water.

Heating by Hot Water.

This is usually a little more economical in fuel than steam heat. Mr. Edgar estimates the good coal burned in St. Louis per season at 24.83 lbs. per square foot hot water radiating surface of an output of 180 B. T. U. per hour. Increased for our inferior fuel this should be about 37 lbs.

The St. Louis Custom House, 8th and Olive Sts., burned in 1898, separately for its hot water heating system, 1122 tons of common coal. The contents of this building being about 4,342,000 cubic feet, the consumption was .26 tons per 1000 cubic feet per season. This was distributed throughout the year as follows:

January	231	tons.
February	190	"
March	87	"
April	60	"
May, June, July, August and September		
October	48	"
November	220	"
December	286	"
Total	1,122	"

This building has very thick walls, the proportion of glass to wall surface is small, and its exposures are favorable.

William H. Bryan (Trans. Am. Soc. Heating and Ventilating Engineers, Vol. VIII), estimates the average consumption of fuel for heating an ordinary building in St. Louis at one pound common coal per season per cubic foot of space heated, for either steam or water. This figure is, of course, affected by the character of the building, its size, exposure, and the system of heating employed. Large buildings, and those heated by hot water, require less, while small buildings, or steam or hot air heating require more.

Heating and Ventilation by the Hot Blast or Fan System.

Heating and Ventilation by the Hot Blast or Fan System.

H. H. Morrison, Chief Engineer Board of Education, reports that a representative modern public school, the "Eugene Field," Olive St. and Taylor Ave., burned during the last heating season, 182 tons of coal. Its cubic contents being 663,600 feet, the consumption in tons per 1000 cubic feet of space heated per season is .27. In common with all modern school buildings in

St. Louis it is heated and ventilated throughout by the indirect "hot blast" or fan system, the air in all the rooms being changed on an average eight times per hour.

Coal Consumed for All Purposes in Commercial Buildings.

Coal Consumed for All Purposes, in Commercial Buildings.

In most modern commercial buildings coal is burned and steam used not only for heating, but throughout the entire year for running dynamos for light and power, running elevators, pumping water, fans, cash systems, etc. The requirements of different buildings vary widely, depending upon the purpose for which they are used, their dimensions, glass, wall and roof exposure, elevator surface, whether steam, hydraulic or electric, and the character of that service, amount and hours of artificial lighting, amount of water pumped, etc. The coal burned depends upon the type of boilers and their settings, kind of engines, whether simple or compound, kind of heating system, etc. The most economical plants in St. Louis are those provided with water-tube boilers set with down-draft or other improved form of furnaces, compound engines direct connected to generators, compound steam pumps, electric elevators, and a vacuum system of steam heating. The actual fuel consumption for a number of representative St. Louis buildings is as follows:

BUILDINGS.	LOCATION.	Contents, cu. ft.	Tons Coal per Year.	
			Total.	Per 1000 cu. ft.
Ferguson-McKinney Dry Goods Co.*	12th & Washington	3,340,000	2,383	.72
Hargadine-McKittrick Dry Goods Co.*	919 Washington,	2,507,000	2,303	.92
Custom House— (new plant)	8th & Olive Sts.,	4,242,000	3,388	.78
(old plant)	" "	4,242,000	4,791	1.23
Chemical†	" "	1,210,000	2,100	1.73
Missouri Trust†	7th "	1,630,000	3,065	1.88
Mercantile Club	" Locust sts.	846,000	2,503	2.96
Columbia†	8th "	195,000	585	4.40

The consumption of coal in the Ferguson-McKinney building was distributed throughout the year 1903 as follows:

January	224	tons.
February	275.5	"
March	215	"
April	141	"
May	171.5	"
June	133.5	"
July	172.5	"
August	218	"
September	202	"
October	199.5	"
November	218.5	"
December	213	"
Total	2,383	"

Total cost of fuel, $5,241.50. Kilo-watt hours generated, 327,312.

*Wholesale Dry Goods. †Office Buildings.

Coal Consumption of Steam Engines.

Coal Consumption of Steam Engines.

Based on ordinary Illinois coal, having an average calorific value of 11,000 B. T. U. per lb. Assumed efficiency of boilers, setting and pipework, 65 per cent.

TYPE OF ENGINE.	POUNDS PER I. H. P. HOUR.			
	Assumed Water Rate.		Coal.	
	Condensing.	Non-Condensing.	Condensing.	Non-Condensing.
Pumps, Simple	75	55	10.14	7.44
" Compound	40	30	5.40	4.05
Slide Valve, Simple	40	30	5.40	4.05
" " Compound	30	23	4.05	3.11
High Speed, Single Valve—				
Simple	35	26	4.73	3.52
Compound	28	21	3.78	2.84
High Speed, Four-Valve—				
Simple	28	21	3.78	2.84
Compound	24	18	3.24	2.44
Corliss, Simple	24	18	3.24	2.44
" Compound	20	15	2.70	2.03
" Triple	16	12	2.16	1.62

Fuel Analyses.

Fuel Analyses.

The following analyses have been selected from a large number made at various times and places, by different chemists, and with many types of apparatus. The extreme difficulty attending this kind of work should be borne in mind when making comparisons. The uncertainty as to getting a representative sample, the variations in the same coal, the changes in its moisture, the troubles attending calorimetric investigation, not to mention the personal equation of the observer, all emphasize the necessity for caution in interpreting results. The figures are not the best, nor the worst of each kind of coal, but it is believed they represent good average results.

All the coals listed are soft bituminous except where otherwise noted.

Authorities—A. St. Louis Sampling & Testing Works.
B. University of Illinois.
C. Illinois Steel Co.
D. Prof. R. C. Carpenter.
E. Wm. Kent.

PROXIMATE ANALYSES AND CALORIFIC VALUES.

COAL.	COUNTY.	SIZE.	British Heat Units or Calorific Power per lb.	Theoretical Evaporation from and at 212° F. in lbs. of Water.	Moisture.	Volatile Matter.	Fixed Carbon.	Ash.	Sulphur (Separate).	Authority.
SOUTHERN ILLINOIS:										
Assumption	Christian	Block	.....	.....	7.25	37.76	47.86	7.13	2.94	B
Auburn	Sangamon	Screenings	11,193	11.60	Dried	37.50	47.30	15.20	.....	D
Barclay	"	.....	11,205	11.62	7.40	35.70	46.20	10.70	3.21	B
Belleville	St. Clair	.....	.....	.....	7.05	33.05	50.40	9.50	3.10	B
"	"	Lump and slack	10,320	10.68	8.42	31.66	43.28	16.64	3.54	A
"	"	Slack and pea	9,430	9.77	6.90	31.54	35.98	25.58	.....	A
"	"	Mine dust	9,300	9.64	8.36	31.32	36.02	24.30	.....	A
Big Muddy	Jackson	Lump	12,190	12.62	7.18	29.39	56.41	7.02	1.39	A
"	"	Screenings	12,420	12.85	5.76	30.25	57.32	6.67	1.18	B
"	"	Duff slack	11,265	11.66	10.28	31.98	44.98	12.76	1.18	A
Bryden Royal	"	Run of mine	10,679	11.05	7.46	34.41	46.35	11.78	4.66	A
Carbondale	"	Vein sample	12,323	12.75	6.32	26.40	59.88	7.40	.80	B
Carterville	Williamson	Run of mine	12,214	12.65	4.87	34.11	52.17	8.85	.85	B
"	"	Hand-picked egg	11,954	12.38	7.57	25.38	57.44	9.61	1.25	A
"	"	Lump	11,500	11.91	5.70	31.63	52.72	9.95	1.46	A
"	"	Washed No. 1	12,286	12.70	4.66	33.99	54.21	7.14	.74	B
"	"	" " 2	12,420	12.85	5.76	30.25	57.32	6.67	1.18	B
"	"	" " 3	.....	.....	3.98	34.66	53.04	8.32	.87	B
"	"	" " 4	12,345	12.80	4.86	33.26	55.29	6.59	1.15	B
Centralia	Marion	.....	.....	.....	8.28	38.18	45.50	8.04	.....	B
"	"	Duff	9,988	10.32	4.88	35.59	40.11	19.42	3.58	A
Collinsville	Madison	Washed No. 3	11,214	11.60	7.23	38.80	43.77	10.20	1.28	A
"	"	Lump	10,720	11.10	9.10	37.21	41.64	12.05	4.18	A
"	"	Nut	10,232	10.59	9.88	31.46	40.64	18.02	2.40	A
"	"	" pea and slack	10,465	10.84	8.14	35.08	38.21	18.57	4.53	A
Dawson	Sangamon	Pea	.....	.....	12.54	33.65	41.40	12.41	5.09	B

PROXIMATE ANALYSES AND CALORIFIC VALUES—Con.

COAL.	COUNTY.	SIZE.	British Heat Units or Calorific Power per lb.	Theoretical Evaporation, from and at 212° F. in lbs. of Water.	Moisture.	Volatile Matter.	Fixed Carbon.	Ash.	Sulphur (Separate).	Authority.
Divernon	Sangamon	Lump	10,262	10.65	8.69	34.72	38.59	18.00	6.03	B
DuQuoin	Perry	"	11,250	11.65	7.59	35.77	47.53	9.11	.....	B
"	"	Nut	11,128	11.50	7.43	38.91	46.00	7.66	.....	B
"	"	Slack	11,050	11.45	6.05	35.95	41.60	16.40	5.14	B
"	"	Pea	.....	.....	3.15	38.94	39.99	17.92	3.18	C
Ellsworth	Macoupin	.....	.....	.....	9.26	42.22	42.17	6.35	2.62	B
Gillespie	"	.....	9,739	10.10	12.61	30.58	45.27	11.54	1.45	A
Girard	"	.....	10,269	10.65	8.90	32.25	42.89	15.96	8.10	A
Glen Carbon	Madison	Lump	11,481	11.88	10.66	34.44	44.55	10.35	4.26	A
"	"	Run of mine	11,041	11.43	10.25	32.64	45.33	11.74	3.84	A
Greenridge	Macoupin	.....	.....	.....	9.26	42.22	42.17	6.35	2.62	B
Heintz Bluff	St. Clair	Lump	11,029	11.42	6.62	33.81	44.27	15.30	6.12	A
Hurricane	Williamson	"	11,455	11.86	6.84	28.26	54.10	10.80	1.72	A
Johnsons	St. Clair	.....	11,732	12.10	5.50	40.41	40.53	13.83	4.80	B
Jupiter	Perry	.....	10,710	11.10	11.30	30.31	49.91	8.48	.....	B
Kinmundy	Marion	.....	11,664	12.10	7.00	34.00	47.45	11.15	7.25	B
Loose's	Sangamon	.....	11,479	11.90	10.71	37.62	45.07	6.60	2.39	A
Maryville	Madison	Run of mine	10,830	11.20	7.28	35.65	42.42	14.65	5.95	A
Mt. Carbon	Jackson	.....	.....	.....	6.1	24.7	66.5	2.70	.....	E
Mt. Olive	Macoupin	Lump	11,160	11.55	8.68	34.87	45.71	10.74	4.05	A
"	"	Run of mine	11,130	11.52	11.98	29.72	48.40	9.90	4.28	A
"	"	Nut	10,594	10.97	7.03	36.06	40.27	16.64	4.97	A
"	"	Slack and nut	10,578	10.95	12.29	32.12	41.30	14.29	4.66	A
Moweaqua	Shelby	Lump	11,700	12.10	9.18	39.58	43.75	7.49	.....	B
Muddy Valley	Jackson	.....	11,718	12.10	5.62	33.94	54.09	6.35	.....	A
Murphysboro	"	Lump	11,766	12.18	.....	.....	.....	.....	.....	A
"	"	"	.....	.....	3.26	35.61	56.37	4.76	.76	B

PROXIMATE ANALYSES AND CALORIFIC VALUES—Con.

COAL.	COUNTY.	SIZE.	British Heat Units or Calorific Power per lb.	Theoretical Evaporation from and at 212° F. in lbs. of Water.	Moisture.	Volatile Matter.	Fixed Carbon.	Ash.	Sulphur (Separate).	Authority.
New Baden	Washington	Lump	10,690	11.07	10.01	35.39	43.42	11.18	4.22	A
Niantic	Macon		11,529	11.90	7.88	36.25	47.80	8.47	.....	B
Oakland	St. Clair		10,395	10.78	8.30	34.40	43.12	14.18	.....	B
Odin	Marion	Lump	12,240	12.68	7.92	38.39	45.77	8.12	.....	B
"	"	Pea	10,890	11.30	7.25	38.17	43.23	11.35	3.61	B
"	"	Slack	11,160	11.55	8.00	34.31	42.26	15.43	.....	B
Pana	Christian		11,610	12.10	7.22	36.37	46.95	9.46	.....	B
"	"	Nut	11,846	12.28	5.30	39.43	46.04	9.23	.....	B
"	"	Pea	.....	.....	4.70	41.20	40.60	13.50	3.68	C
"	"	Slack	9,810	10.15	8.55	35.45	39.35	16.65	4.77	B
"	"	Duff	.....	.....	4.88	35.59	40.11	19.42	3.58	C
Paradise	Perry	Lump	11,970	12.38	9.63	37.00	51.10	2.27	.....	B
Reinecke	St. Clair		.....	.....	7.56	39.81	42.49	10.14	4.02	B
Rentschler	"	Run of mine	10,961	11.35	9.87	29.74	47.92	12.47	3.98	A
Ridgely	Sangamon		.....	.....	9.41	36.94	41.44	12.21	4.09	B
Riverton	"		11,633	12.00	6.38	35.39	48.45	9.78	3.27	B
"	"	Pea	.....	.....	3.94	41.10	39.88	15.08	3.96	B
Sandoval	Marion		11,959	12.38	7.19	35.07	50.86	6.88	.....	B
Sangamon	Sangamon	Lump	10,980	11.35	12.47	35.44	40.54	11.52	.....	B
Sorento	Bond	Slack and pea	9,675	10.02	8.60	33.50	35.10	22.80	4.15	A
Spaulding	Sangamon	Lump	10,980	11.36	12.47	35.44	40.57	11.52	.....	B
Springfield	"		.....	.....	10.45	35.89	41.68	11.98	2.99	B
" Junction	"		.....	.....	9.11	37.04	43.52	10.33	3.65	B
Staunton	Macoupin	Lump	11,160	11.55	8.68	34.87	45.71	10.74	4.05	A
"	"	Nut	10,439	10.81	8.29	36.20	40.48	15.03	4.36	A
St. Bernard	"		10,080	10.44	14.36	30.86	48.39	6.39	1.38	A
St. Clair	St. Clair		10,294	10.65	10.25	33.10	41.79	14.81	6.92	A

PROXIMATE ANALYSES AND CALORIFIC VALUES—Con.

COAL.	COUNTY.	SIZE.	British Heat Units or Calorific Power per lb.	Theoretical Evaporation from and at 212° F. in lbs. of Water.	Moisture.	Volatile Matter.	Fixed Carbon.	Ash.	Sulphur (Separate).	Authority.
St. Johns	Perry		9,765	10.10	9.82	28.35	45.77	16.08	2.06	B
Superior	"	Nut	9,848	10.19	6.54	31.30	46.36	15.80	3.90	A
Trenton	Clinton		11,245	11.63	9.95	31.04	52.03	6.98	1.04	A
Troy	Madison	Lump	10,850	11.22	9.56	31.18	43.94	15.32	2.84	A
Turkey Hill	St. Clair		11,260	11.65	9.25	34.73	42.68	9.72	3.62	A
Virden	Macoupin	Nut			5.15	40.82	43.54	10.49	3.78	C
Vulcan	St. Clair	"	10,626	11.00	10.30	27.91	48.99	12.80	.71	A
Walnut Valley	"	Lump	11,137	11.53	7.75	35.99	44.33	13.93	4.87	A
Wilderman	"	Nut	10,300	10.66	10.65	45.36	47.13	17.63	4.76	A
Williamsville	Sangamon	"			2.45	43.50	41.69	12.36	4.20	C
"	"	Pea			2.65	42.25	42.62	12.48	3.70	C
Willis	Perry	Run of mine	11,352	11.75	7.22	30.67	50.17	11.94	3.71	A
MISSOURI:										
St. Louis	St. Louis				9.55	38.28	42.99	9.18		E
Rich Hill	Bates		12,307	12.76	4.44	32.80	51.22	11.74	4.23	A
Lexington	Lafayette		10,944	11.32	10.76	30.71	48.94	9.59	3.20	A
ARKANSAS:										
Coal Hill	Johnson		14,637	15.20	.87	11.49	79.54	8.10	3.28	A
Denning			14,841	15.40	.92	12.78	79.21	7.09	1.59	A
Eureka	Johnson		13,638	14.12	1.22	10.78	77.86	10.14	3.36	A
Huntington	Huntington		11,907	12.32	1.30	18.90	73.15	6.65	.75	A
Jenny Lind	Sebastian		14,744	15.30	.94	14.27	77.67	7.12	1.57	A
Ouita	Pope		14,500	15.10	1.89	11.14	80.31	6.66	1.36	A
Spadra	Johnson		14,420	14.90	1.47	13.27	78.63	6.63	1.60	A

PROXIMATE ANALYSES AND CALORIFIC VALUES—Con.

COAL.	COUNTY.	SIZE.	British Heat Units or Calorific Power per lb.	Theoretical Evaporation from and at 212° F. in lbs. of Water.	Moisture.	Volatile Matter.	Fixed Carbon.	Ash.	Sulphur (Separate).	Authority.
INDIAN TERRITORY:										
Cherokee		Lump and slack	11,997	12.40	2.12	33.78	51.90	12.20	4.20	A
"		Slack	10,671	11.03	4.07	30.05	45.68	20.20	5.94	A
Choctaw Nation			12,789	13.23	1.59	23.31	66.85	8.25	1.18	A
McAlester		Lump	13,500	14.00	2.18	30.06	63.22	4.54	.67	A
"		Slack	12,319	12.78	2.34	30.21	56.25	11.20	.91	A
Atoka		Lump	11,858	12.28	4.68	32.88	51.38	10.86	3.81	A
MISCELLANEOUS:										
Anthracite			13,160	13.62	3.42	4.38	83.27	8.20	.73	E
Pittsburg			13,104	13.46	1.80	35.34	54.94	7.92	1.97	A
Pocahontas		Lump	13,029	13.49	1.20	17.64	75.56	5.60	.90	A
Coke.										
Connellsville			12,850	13.30	.34	.65	88.23	10.78	.72	A
Gas House			12,300	12.73	.60	1.41	83.39	14.60	1.08	A
McAlester, I. T. 72-hour			13,054	13.50	.63	1.78	88.18	9.41	1.02	A

ULTIMATE ANALYSES OF COALS WITH CALCULATED CALORIFIC POWERS.

Contributed by Prof. Wm. B. Potter, Mgr. St. Louis Sampling and Testing Works.

NAME OF COAL AND LOCALITY.	Moisture.	Volatile Matter.	Fixed Carbon.	Ash.	Sulphur.	Total Carbon.	Total Hydrogen.	Oxygen.	Nitrogen (*assumed).	Carbon in Hydrocarbon.	Hydrogen in Hydrocarbon.	Hydrogen in Combined Water.	Combined Water.	Calculated Calorific Power B. H. U.	Calculated Calorific Intensity, degrees F.	Theoretical Evaporation from and at 212° F. Lbs. Water.
Big Muddy, Jackson Co., Ill.....	6.35	31.50	55.25	6.90	2.02	69.80	5.26	8.35	1.33	14.55	4.216	1.044	9.934	12,567	3,942	13.0
Ellsworth, Macoupin Co., Ill.....	9.26	42.22	42.17	6.35	2.62	67.08	5.22	7.97	*1.5	24.91	4.225	0.996	8.966	12,175	4,727	12.6
Mt. Olive, Macoupin Co., Ill.....	10.38	36.68	46.10	6.84	3.53	64.68	5.70	7.37	*1.5	18.58	4.78	0.92	8.29	11,763	4,517	12.2
Reinecke, St. Clair Co., Ill.....	7.56	39.81	42.49	10.14	4.02	64.86	5.13	6.79	*1.5	22.37	4.28	0.85	7.64	11,720	4,662	12.1
Johnson's, St. Clair Co., Ill.....	5.50	40.14	40.53	13.83	4.80	64.06	5.02	5.298	*1.5	23.53	4.298	0.662	5.96	11,723	4,722	12.1
Loose's, Sangamon Co., Ill.....	10.71	37.62	45.07	6.60	2.39	65.22	4.90	8.68	*1.5	20.15	3.85	1.05	9.73	11,479	4,621	11.9
Riverton, Sangamon Co., Ill.....	11.06	77.94	42.98	8.02	3.27	64.10	4.86	7.19	*1.5	21.12	3.90	0.90	8.09	11,406	4,635	11.8
Spadra, Johnson Co., Ark.....	1.47	13.27	78.63	6.63	1.60	83.74	4.52	0.54	*1.5	5.11	4.453	0.067	0.607	14.420	4,797	14.9
Jenny Lind, Sebastian Co., Ark..	1.26	17.64	72.48	8.62	2.11	78.48	4.96	3.18	*1.5	6.00	4.56	0.40	3.58	13,964	4,847	14.4
Huntington, Ark.....	1.30	18.90	73.15	6.65	0.75	79.65	5.58	4.66	*1.5	6.50	4.998	0.582	5.242	13,752	4,651	14.2
Coal Hill, Johnson Co., Ark.....	1.35	14.93	74.06	9.66	3.04	77.52	4.52	2.48	*1.5	3.46	4.21	0.31	2.79	13,713	4,865	14.1
Pittsburg, Pa., Coking Coal.....	1.43	30.22	61.87	6.48	1.35	79.81	5.98	4.80	*1.5	17.94	5.38	0.60	5.40	14,415	4,735	14.9
Pittsburg (average of 5 samples).	1.80	35.34	54.94	7.92	1.97	75.66	5.69	5.46	*1.5	20.72	5.01	0.68	6.14	13,684	4,705	14.2
Briar Hill, Mahoning Co., Ohio...	2.47	31.83	64.25	1.45	0.56	78.99	5.92	11.50	1.58	14.74	4.48	1.44	12.94	13,714	4,223	14.2
Hocking Valley, Ohio.....	8.25	35.88	53.15	2.72	0.43	72.29	6.53	8.28	*1.5	19.14	5.50	1.03	9.31	13,414	4,617	13.9
Glen Mary, Scott Co., Tenn.....	2.15	31.47	61.63	4.75	0.94	76.68	6.09	4.89	*1.5	18.05	5.48	0.61	5.50	14,422	4,731	14.9
Indiana Block	3.50	32.50	63.00	1.00	0.98	82.70	4.77	8.81	1.74	19.70	3.669	1.101	9.911	14,020	4,839	14.5

Selling Prices of Electric Current.

Selling Prices of Electric Current.

This, as everywhere, varies with the location, quantity, duration and hours of the load, and only approximate figures can therefore be given. The kilo-watt hour is the universal unit. The lighting charge ranges between 6 and 15 cents per unit. The latter figure is charged in residences, with a minimum monthly charge of 25 cents per room, the lighting company furnishing all lamp renewals. For power the charge ranges between 4 and 10 cents per unit. Nearly all charges are now by meter. Some few plants are still operated on flat rates, including a number of electric elevators, the monthly charge for which ranges between $10 per month for freight hoists doing light service, up to $50 per month for busy passenger elevators.

Cost of Laying Water Pipe.

Cost of Laying Water Pipe.

The cost of laying cast iron water mains of all sizes is from $8.00 to $10.00 per ton of 2000 lbs. This includes distribution, trenching, laying, jointing, back filling and testing. Recent contract prices per foot were as follows:

LOCATION.	Depth of Cover.	4"	6"	8"	10"	12"	20"	30"	36"
City of St. Louis.....	4.0 ft.	.25	.30	....	....	.39	.93	1.50	2.00
" " Webster Groves.	3.5 "	.16	.20	.24	.26	.30	....	....	....

Foundation Pressures.

Foundation Pressures.

The character of the soil varies so widely in St. Louis and vicinity that only general figures can be given. The City Building ordinances permit a maximum loading of 3 tons per square foot on good solid natural clay. There are a few favorable cases where the actual loadings are as high as 4 tons, without noticeable settlement. A limiting condition in less favorable soil is found in the old settling basins of the water works, which rest on a filled foundation of clay two feet thick. This in turn rests on alluvial ground near the river bank. The maximum pressure, estimated at 1.6 tons per square foot, is found at a depth of 1.5 feet below the floor of the basin. Some settlement has occurred, but the walls are still in good condition.

DIVISION IV.

Ninth Annual Bulletin

OF THE

Engineers' Club

OF

St. Louis.

Reports of Officers and Committees.
List of Officers and Members.
Constitution, By-Laws and Reports.

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1904.

Engineers' Club

Officers of the Engineers' Club of St. Louis, 1904.

OFFICERS OF THE ENGINEERS' CLUB OF ST. LOUIS, 1904

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Vice-President—Robert Moore, Laclede Building.
Secretary—R. H. Fernald, Washington University.
Librarian—E. B. Fay, 1009 Fullerton Building.
Directors—J. L. Van Ornum, E. A. Hermann.
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Committees, 1904.

COMMITTEES, 1904

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Entertainment—F. E. Bausch, Chairman; T. M. Post, A. L. Johnson.

Programme, 1904.

PROGRAMME, 1904.

Jan. 6th—"Vital Statistics of St. Louis since 1840," Robert Moore.
Jan. 20th—"International Morality and the Panama Question," Prof. A. O. Lovejoy.
Feb. 3d—"Protection of the American Bottom Against Overflow and Regulation of the Mississippi in the Harbor of St. Louis," Julius Pitzman.
Feb. 17th—"The Inter-Continental Railway," Robert Burgess.
March 2d—"A Study of Lord Kelvin's Suggestion for a Heating Plant," Dr. A. L. McRae.
March 16th—"Armored Concrete Construction," Hughes Brussel.
April 6th—"World's Fair Terminals of the Local Traction Companies and Proposed Methods of Handling Visitors to the Exposition," C. A. Moreno.

April 20th—"Sidelights on South Africa, Past and Present," Capt. A. W. Lewis.

May 4th—"A Suggestion Concerning the Water Supply of St. Louis," R. D. O. Johnson.

May 18th—"The Sheetfloods of the Arid Regions as Affecting Engineering Works," Dr. WJ. McGee.

June 1st—"A Suggestion Concerning the Water Supply of St. Louis," R. D. O. Johnson.

Summer Recess.

Sept. 21st—"Some Experiences as a Municipal Contractor," F. P. Spalding.

Oct. 5th—"The Panama and the Nicaragua Canals Compared," J. L. VanOrnum.

Oct. 19th—"The Classification of Engines for Bridge Loading," C. D. Purdon.

Nov. 2d—"Possibilities and Limitations of Industrial Arbitration and Concilation," Prof. A. P. Winston.

Nov. 16th—"Tests of Relative Merits of Stone and Gravel for Concrete," Wm. H. Henby.

Dec. 7th—Annual meeting. Reports of Officers and Committees.

Dec. 21st—Annual Dinner.

CERTIFICATE OF INCORPORATION

Certificate of Incorporation.

In the Circuit Court of St. Louis County,

April Term, 1869.

Wednesday, May 12, 1869.

Whereas, Henry Flad, Geo. W. Fisher, Thomas J. Whitman, L. Fred'k Rice, T. A. Meysenburg, William Eimbeck, Charles Pfeifer, C. E. Illsley, Geo. P. Herthel, Jr., Jos. P. Davis and James Andrews have filed in the office of the Clerk of the Circuit Court their Articles of Association, in compliance with the provisions of an "Act Concerning Corporations," approved May 12, 1869, with their petition for incorporation under the name and style of the

"Engineers' Club of St. Louis, Mo.,"

they are, therefore, hereby declared a body politic and corporate under the name and style aforesaid, with all the powers, privileges and immunities granted in the act above named.

By order of the Circuit Court.

Attest:

[Seal] JOHN LEWIS,

Clerk of the Circuit Court of St. Louis County.

Report of Executive Committee.

REPORT OF EXECUTIVE COMMITTEE

St. Louis, Mo., Dec. 2, 1903.

To the Members of the Engineers' Club of St. Louis:

Gentlemen—I have the honor to submit the following report of your Executive Committe for the year 1903:

The eighteen meetings which have been held have naturally been mainly concerned with routine matters of executive character, details of which are a matter of record in the minutes of the committee. It is thought best to refer, in this general report, to only the more important decisions.

In accordance with the recommendation of the Treasurer one year ago, it was determined that checks drawn by the Treasurer should be countersigned by the Secretary.

Because of occasional irregularity and difficulty in differentiating between "Resident" and "Non-Resident" membership, after extended deliberation, the committee ruled that "Resident members shall include all members who live, or have their place of business, in St. Louis.".

In view of the somewhat greater expenses connected with occupancy of our present quarters, and anticipating especial outlay during the Exposition next year, this committee deemed it necessary, at the beginning of the year, to fix the membership dues for one year at the maximum limit provided for by the By-Laws.

The nearness of the Exposition period and the desire of our Engineers' Club to prepare to assume its share of interest and responsibility in the professional entertainment of visiting Engineers, caused the Executive Committee, a short time ago, to recommend to the Engineers' Club the appointment of a special committee to consider details of keeping open headquarters at our Club rooms, the publishing of hand books of engineering data and information and allied matters; the Club adopted this recommendation, authorizing the Executive Committee to appoint such committee. Following this authorization a committee on Exposition affairs, consisting of Messrs. S. B. Russell, H. A. Wheeler, W. H. Bryan, A. S. Langsdorf and C. A. Moreno, was appointed, and has already vigorously entered upon its work.

Other general affairs of the Engineers' Club are detailed at length in the report of the Secretary and the finances of the Club are covered in the Treasurer's report. To these and other reports of officers and committees the membership is referred for the progress of this society during the past year.

To the large measure of co-operation of members in the affairs of the Engineers' Club is due the influence and value of the organization. By encouraging the special interests of the

several branches of engineering represented, and at the same time by preserving and promoting united interest in the affairs of general engineering concern we shall be able to strengthen, enlarge and intensify the work of the Engineers' Club of St. Louis.

Respectfully submitted,

J. L. VAN ORNUM, President,
Chairman of the Executive Committee.

REPORT OF SECRETARY

Report of Secretary.

To the Members of the Engineers' Club of St. Louis:

Gentlemen—I have the honor to submit the following report:

There have been eighteen regular meetings of the Club, one of which was held at the St. Nicholas Hotel, and the others at the Club rooms.

Vice-President Van Ornum presided at one meeting, President Kinealy at one, President Van Ornum at thirteen, Vice-President Ockerson at two, and Mr. E. R. Fish at one.

The total attendance at all of the regular meetings was four hundred and seventy-seven (477) members and one hundred and twenty-seven (127) visitors, making an average attendance of twenty-seven (27) members and seven (7) visitors at each meeting, a decrease of three (3) members and two (2) visitors from the attendance of last year. One meeting was an open one at which a number of a ladies accepted the hospitality of the Club.

During the year thirty-two (32) new members were elected, eight (8) resigned, ten (10) were dropped from the rolls for non-payment of dues, and we have also lost by death two members, Mr. Edmund Dorman Libby and Mr. Geo. W. Fisher (a charter member).

Our present membership consists of one hundred and sixty-five (165) resident members and sixty-eight (68) non-resident members, making a total of two hundred and thirty-three (233) as compared with a total of two hundred and twenty-one (221) members a year ago.

During the year eleven (11) papers and addresses were presented by the following members:

W. A. Layman, F. Schwedtman, E. J. Spencer, John Dean, R. H. Fernald (2), R. H. Phillips, J. J. Kessler, C. D. Purdon, A. S. Langsdorf, A. P. Greensfelder.

And six (6) papers and addresses by the following non-members:

W. Cooper, T. H. Bean, J. E. Conzelman, P. E. Fansler, W. M. Carr, F. M. Mann.

Of these papers, eight were approved for publication in the Journal, seven (7) being by members and one by a non-member.

Report of Secretary.

Following the usual custom the Annual Bulletin was issued during the year. The receipts from advertisements more than paid the cost of publication, leaving a balance of one hundred and fifty-four dollars and ninety cents, of which $15.00 is still to be collected, and one hundred and thirty-nine dollars and ninety cents has been turned into the lunch fund.

On March 12, 1903, Mr. E. L. Corthell delivered a lecture at the Mercantile Club under the joint auspices of the Engineers' Club and of the Mercantile Club. His subject was "The Public Works of the Argentine Republic, South America," The lecture was preceeded by a supper at the Mercantile Club. A large number of our members availed themselves of the opportunity of hearing this distinguished engineer and the meeting was in every way successful.

During the year the Club was the guest of the St. Louis Railway Club on two occasions, one being a meeting at the Mercantile Club in April, and the other a trip through the World's Fair grounds in September. Both meetings were very well attended by our membership and thoroughly enjoyed.

On April 3, 1903, the Club was the guest of the Local Chapter of the American Institute of Electrical Engineers, at which time Mr. B. J. Arnold read a paper on the "Chicago Transportation Problem." On account of the masterly manner in which Mr. Arnold handled his subject, and also on account of the importance of the urban transportation question the meeting proved to be very successful and well attended.

Through the courtesy of Mr. R. H. Phillips the Club was enabled to take a trip to the World's Fair grounds on April 18, 1903. We had as our guest on this occasion the St. Louis Railway Club. The St. Louis Transit Co. kindly furnished cars for the trip to the Fair grounds, and the Exposition Co. furnished a special inspection train. A luncheon was served in one of the service buildings on the Fair grounds, and a thoroughly enjoyable time was had. The total attendance was well over two hundred.

Through the courtesy of the St. Louis Portland Cement Co., the Burlington R. R., the Wabash R. R. and the Terminal R. R. Association, the Club was enabled to visit the plant of the St. Louis Portland Cement Co., and also the Belt Line of the Terminal R. R. Association on May 30, 1903. This trip was enjoyed by a large number of our members and their friends.

In conclusion the Secretary desires to express his thanks to the officers and members of the Club and to the advertisers in the Annual Bulletin for their assistance in carrying on the work of the Club.

Respectfully submitted,

H. J. PFEIFER, Secretary.

REPORT OF TREASURER

St. Louis, Mo., Dec. 2, 1903.

Engineers' Club of St. Louis:

Gentlemen—As Treasurer of the Club I have the honor to submit the following report:

GENERAL FUND.

Debits.

Cash on hand Dec. 3, 1902	$1,026 79	
Delinquent dues receipts received	428 00	
Transferred from resident membership	5 00	
1903 dues receipts received (resident)	1,796 47	
1903 dues receipts received (non-resident)	427 00	
Initiation receipts received	340 00	
		$4,023 26

Credits.

Delinquent dues receipts on hand	$ 60 00	
Delinquent dues receipts cancelled	123 00	
1903 dues receipts on hand (resident)	254 17	
1903 dues receipts on hand (non-resident)	42 00	
1903 dues receipts cancelled (resident)	110 00	
1903 dues receipts cancelled (non-resident)	18 00	
Initiation receipts on hand	10 00	
Initiation receipts cancelled	20 00	
Bills paid	1,424 35	
Cash on hand	1,961 74	
		$4,023 26

LIBRARY FUND.

Debits.

Cash on hand December 3, 1902	$ 22 92	
Transferred from General Fund	150 00	
		$ 172 92

Credits.

Bills paid	$ 57 47	
Cash on hand	115 45	
		$ 172 92

LUNCH FUND.

Debits.

Cash on hand December 3, 1902	$ 93 45	
Received from Laclede Gas Company	5 00	
Received from Bulletin Fund	139 90	
		$ 238 35

Credits.

Bills paid	$ 230 85	
Cash on hand	7 50	
		$ 238 35

Report of Treasurer.

BULLETIN FUND.

Debits.

Advertisements in 1903 Bulletin	$ 403 50	
		$ 403 50

Credits.

Bills paid	$ 263 60	
Transferred to Lunch Fund	139 90	
		$ 403 50

ENTERTAINMENT FUND.

Debits.

Cash on hand Dec. 3, 1902	$1,212 77	
Interest St. Louis Union Trust Company	8 14	
Interest St. Louis Union Trust Company	8 26	
Interest Lincoln Trust Company	49 66	
Interest Colonial Trust Company	3 50	
Interest Commonwealth Trust Company	9 63	
		$1,291 96

Credits.

Cash on hand	$1,291 96

RECAPITULATION.

Cash Assets.

General Fund	$1,961 74	
Library Fund	115 45	
Lunch Fund	7 50	
Entertainment Fund	$1,291 96	
		$3,376 65

Cash Deposited.

Lincoln Trust Company	$1,693 19	
St. Louis Union Trust Company	560 07	
Commonwealth Trust Company	1,123 39	
		$3,376 65

Respectfully submitted,

E. E. WALL, Treasurer.

December 15, 1903.

We, the undersigned, appointed a committee to audit this statement, hereby certify that we have examined the accounts of the Treasurer for the period covered by this statement and we find the same to be correct.

W. G. BRENNEKE,
H. J. PFEIFER.

Report of Librarian.

REPORT OF LIBRARIAN

St. Louis, Mo., Dec. 2, 1903.

Members of the Engineers' Club of St. Louis:

Gentlemen—The Treasurer's records show the following expenditures for the Library during the year:

New books and subscriptions	$ 42 72	
Binding	13 80	
Miscellaneous	95	
		$ 57 47

The receipts have been as follows:

Cash on hand from 1902	$ 22 92	
Transferred from General Fund	150 00	
		$172 92
Balance on hand		$115 45

Report of Librarian.

New books and periodicals continue to be added to the library, and several gifts of books, magazines, etc., have been received during the year.

Respectfully submitted,

E. B. FAY, Librarian.

REPORT OF BOARD OF MANAGERS

Report of Board of Managers.

St. Louis, Mo., Dec. 2, 1903.

Engineers' Club of St. Louis:

Gentlemen—As your representatives on the Board of Managers of the Association of Engineering Societies, we beg to report as follows:

There have been no questions of any importance that have come before the Board during the past year, but the status of the Association can not be considered as being quite so satisfactory as it was a year ago. We have been subjected to a sharp advance in rates by the printers of the Journal, which will result in a reduction of the net assets at the close of this year, although we shall even then still have a comfortable working balance. The $2.00 asseessment rate has been maintained this year. But unless a more favorable arrangement can be made for printing the Bulletin it may be necessary to advance this yearly assessment. Steps to get a lower rate for the printing are now being taken.

At the close of October, 1903, the total number of names on the mailing list of the Society was 1594 as against 1550 at the same time last year. Of this number 217 are outside subscribers.

The volume of papers published during the past year shows a sad falling off, the comparison being as follows:

	1902.	1903.
January to June, inclusive	386 pages.	358 pages.
July to September, inclusive	142 pages.	88 pages.

Making a total from January to September, inclusive, of 446 pages this year as against 528 pages last year.

No paper published this year seems to have attracted any special attention, or brought about any extraordinary demand for the issue containing it.

Report of Board of Managers.

Last year the Cincinnati Society withdrew from membership, but failed to comply with the provisions of the articles of association respecting the withdrawal of societies, and all efforts on the part of our Secretary to have them observe their duties in this connection have proved unavailable, and they can hardly be properly considered either a member or non-member of the Association. Their refusal to properly abide by the articles according to their agreement when they entered the Association is devoid of a sense of honor to say the least.

It has been our intention to make as active a canvass as possible for the purpose of securing advertisements for the Journal, so as to reduce the demand on the treasury of this Club for the payment of the yearly assessment. The Board allows local societies 90 per cent of the amount derived from such advertisements and with sufficient activity enough advertisements may be obtained to entirely pay for the assessment of the Association. Confining personal business, however, on the part of your members has allowed the year to pass without any very active steps having been taken to secure these advertisements, but in view of the calls which will undoubtedly be made on our treasury during the coming year we would urge that some active measure be taken to secure enough advertisements to pay whatever amount the Association will ask of us. This will help to keep down our yearly dues by reserving this assessment to our own treasury. Respectfully submitted,

E. R. FISH,
F. E. BAUSCH.

Report of Prize Committee.

REPORT OF PRIZE COMMITTEE

St. Louis, Nov. 27, 1903.

Executive Committee Engineers' Club of St. Louis:

Gentlemen—Your Committee on Award of Prize for the best paper read before the Club during the year ending with June, 1903, have to report that they have carefully considered the papers in competition, and beg to state that in their judgment the paper by Mr. C. D. Purdon, entitled "Grade Reduction," read before the Club on May 6, 1903, is the most meritorious. We therefore recommend the award of the prize to Mr. Purdon.

Very respectfully,
WM. H. BRYAN,
PHILIP N. MOORE,
A. P. GREENSFELDER,
GERARD SWOPE,
A. H. ZELLER.

REPORT OF COMMITTEE ON SMOKE PREVENTION

St. Louis, Mo., Dec. 2, 1903.

Members Engineers' Club of St. Louis:

Gentlemen—Your Committe on Smoke Prevention begs leave to report as follows:

Your Committee has not been very active during the year, for the reason that there appeared to be but little for it to do. Your Committee has, however, kept in touch with the work which is being done by the City officials under the Smoke Abatement Ordinances, and has maintained its interest in the development of improved apparatus.

In the judgment of your Committee, the City is to be congratulated upon the present excellent enforcement of the ordinances by the officials charged with that duty. While there is still some smoke, most of which could be abated by proper effort, it is, nevertheless, true that there has been a marked improvement in the atmosphere. The Engineers' Club of St. Louis should thoroughly support the authorities in this work, and encourage them to further legitimate and intelligent effort.

No smoke abatement apparatus of marked novelty has been developed during the past year, but many of the existing forms have been improved and perfected so as to give satisfactory service under a wider range of conditions. Many experimenters are now working in the direction of utilizing powdered fuel, but so far as your Committee knows, none of these furnaces have as yet proved their reliability and efficiency under steam boilers.

Your Committee has been working in harmony with a similar Committee of the Civic Improvement League, all the members of which committee are members of this Club, three of them members of this Committee, your Chairman being chairman also of that committee.

In common with all other good citizens, members of the Engineers' Club should lend their influence to the education of the public in the direction of a clearer atmosphere. Thus far, the City Ordinances have been uniformally upheld by the Courts, but we have information that the constitutionality of the law is soon to be attacked by an appeal to the Supreme Court.

The Engineers' Club of St. Louis can further this movement, both as a club and individually, by encouraging the use of better kinds of smoke abating apparatus, the distribution of knowledge in regard to proper methods of firing, assistance in better boiler room and furnace design, advocacy of electric power in place of small boiler plants, and the use of smokeless fuels in the residence districts. If it is thought wise to continue a Com-

Report of Committee on Smoke Prevention.

mittee on Smoke Abatement, members of the Club could serve it by calling its attention to any improved apparatus and methods which come under their observation.

In view of the important position which this Club has always maintained as leaders in the smoke abatement movement, and to which the results attained are in a considerable measure due, and in view of the universal desire for a clearer atmosphere during the Worlds Fair period, at least, your Committee is of the opinion that it would be well for the Club to continue this work during the coming year.

Respectfully submitted,

WM. H. BRYAN, Chairman.

Report of Governing Board.

REPORT OF GOVERNING BOARD

St. Louis, Nov. 30, 1903.

Mr. J. L. Van Ornum,

President Engineers' Club of St. Louis.

Dear Sir—Your Committee to represent the Engineers' Club as members of the Governing Board of the Associated Technical Club of St. Louis, have the honor to report that four meetings have been held during the year, on Jan. 20th, March 18th, May 5th and May 26th, 1903, respectively. The minutes of these meetings were sent to your Secretary and read by him from time to time at our regular meetings, and are a part of your records.

We desire to state, however, that during the year several mooted questions in regard to provisions in the lease of our quarters have been settled with the Empire Realty Co., which has inured to the benefit of the Club. We desire to state that from Dec. 1st on, arrangements have been made with the janitor of the building to take charge of our quarters, the result of which will be to increase the usefulness of the quarters to the Club. Heretofore these quarters have been open from 12 m. to 10 p. m. only, but with the new arrangement access may be had to them from 9 a. m. to the usual closing hour, a change which we believe will be appreciated by the members of the Club.

In conclusion we desire to recommend that the members of the Board be appointed for two years, one each year, so that the Club will always have one representative on the Board conversant with its affairs for the previous year.

Respectfully submitted,

H. H. HUMPHREY,
A. H. ZELLER,
Committee.

CONSTITUTION

Constitution.

Adopted Nov. 26, 1884.

ARTICLE I.

Name, Location, Objects.

Name, Location, Objects.

Section 1.—The name of this Association shall be "The Engineers' Club of St. Louis," and the permanent place for the transaction of the business of the Club shall be the City of St. Louis, Mo.

Sec. 2.—The objects of the Club shall be the professional improvement of its members, and the advancement of engineering in its several branches.

Sec. 3.—Among the means to be employed for the attainment of these objects shall be the periodical meetings for the reading of professional papers, and the discussion of scientific subjects, the formation of a library, the collection of maps, drawings and models, and the publication of such parts of its proceedings and other engineering matter as may be deemed expedient.

ARTICLE II.

Membership.

Membership.

Section 1.—The membership of the Club shall be divided into two classes: Members and Honorary Members.

Sec. 2.—Members shall be persons actually engaged in any branch of engineering, and others, not engineers, who are known to be interested in the advancement of physical or mechanical science.

Members shall be admitted into the Club and dismissed therefrom in accordance with such rules as may be prescribed by the By-Laws.

Sec. 3.—Honorary Members shall be persons eminent in engineering or mechanical science, and shall be elected upon the recommendation of the Executive Committee, by letter ballot which shall be sent to the members at the same time as the ballot for the annual election of officers. Ninety-five per cent of the votes cast for the candidate must be in his favor to insure election. Honorary Members shall be entitled to all the privileges of members, excepting the right to vote and hold office, and shall be subject to no fees or assessments of any kind.

ARTICLE III.

Officers and Their Duties.

Officers and Their Duties.

Section 1.—The Officers of the Club shall be a President, a Vice-President, a Secretary, a Treasurer, a Librarian, and two Directors, who shall be chosen by ballot in the month of December in each year, and shall hold their offices for one year, or

Officers and Their Duties.

until their successors are duly elected. Vacancies shall be filled at the first meeting after they occur.

Balloting for officers shall be conducted in such a manner as shall be prescribed by the By-Laws.

Sec. 2.—The duties of the President, Vice-President, Secretary and Treasurer shall be such as are customary for such officers, and such as shall be prescribed by the By-Laws.

The Directors shall be members of the Executive Committee, whose duties are defined in Article IV.

The duties of the Librarian shall be such as are prescribed by the By-Laws.

The offices of Secretary and Librarian may be held by the same person.

ARTICLE IV.

Executive Committee.

Executive Committee.

Section 1.—The President, Vice-President, Secretary and the two Directors shall constitute an Executive Committee, whose duty it shall be to consider and recommend plans for promoting the objects of the Club; to audit all bills against the Club, and direct payment of such as they shall approve, to consider all applications for membership; and generally to administer the business of the Club subject to the Constitution and By-Laws, and to such instructions as may be given them by the Club from time to time.

Sec. 2.—No action of the Executive Committee shall be taken except upon the affirmative vote of three of its members. All doings of the Executive Committee shall be reported to the Club and entered upon its records.

ARTICLE V.

Meetings—Quorum.

Meetings—Quorum.

Section 1.—The Annual Meeting of the Club shall be held on the evening of the first Wednesday in December.

Other meetings may be held at such times as the Club may appoint.

Meetings may be called at any time by the Executive Committee, or by the President upon the request of three members.

Sec. 2.—At the annual meeting reports shall be presented: By the Executive Committee through the President; by the Secretary; by the Librarian; and by the Treasurer of the Club.

At the annual meeting also nominations shall be made of candidates for office for the ensuing year, to be voted upon at the time, or by letter ballot if the By-Laws should so prescribe.

Sec. 3.—Seven members shall constitute a quorum for the transaction of business, but a less number may meet and adjourn the Club to another day, and enter such action on the records of the Club.

ARTICLE VI.

Amendments.

Amendments.

Section 1.—Amendments to these articles may be proposed by a a two-thirds vote of any meeting of the Club, but no amendment shall be adopted until it shall be further ratified by two-thirds of the votes cast at a letter ballot to be conducted as prescribed in the By-Laws.

BY-LAWS

By-Laws.

April, 1902.

Section 1.—Order of Business.—The Order of Business for all meetings, shall be as follows:

1. Reading of the Minutes of last Meeting.
2. Report of Executive Committee.
3. Miscellaneous Business.
4. Business of the day.
5. Adjournment.

But this order may be temporarily suspended by consent of three-fourths of the members present at any meeting.

Sec. 2.—Dues.—After January 1, 1890, the Initiation fee shall be ten dollars ($10.00). The annual dues shall be fixed at the beginning of the year by the Executive Committee, but such dues shall not exceed, for resident members, ten dollars ($10.00), and for non-resident members, six dollars ($6.00). Members elected during the year shall be assessed by the Executive Committee a proportional part of the dues for that year. Assessments for special purposes may be made upon recommendation of the Executive Committee by a two-thirds vote of members present at any meeting, provided that the total amount of such assessment in any one calendar year shall not exceed ten dollars ($10.00).

Sec. 3.—Notice of Meetings.—It shall be the duty of the Secretary to mail to every member a written or printed notice of the time and place of every meeting not less than two days before such meetings.

Sec. 4.—Librarian.—The Librarian shall have the custody of all the books and collections of the Club.

Sec. 5.—Treasurer.—The Treasurer shall collect all moneys due the Club, be custodian of all its funds, and pay such bills against the Club as the Executive Committee shall approve. The Treasurer shall deposit the moneys and invest the funds of the Club in its name and with the advice of the Executive Committee.

Besides his Annual Report to the Club, the Treasurer shall make such further reports and statements concerning the finan-

cial affairs of the Club as the Executive Committee may from time to time require.

Sec. 6.—Executive Committee.—The Executive Committee shall act as a publication committee; shall prepare a program for each meeting; and may pass such rules and regulations for their own guidance, not inconsistent with the Constitution and By-Laws, as they deem proper.

Sec. 7.—Election of Members.—Candidates for admission to the Club as members shall be proposed by not less than two members at any meeting of the Club. The proposal shall contain a statement signed by the candidate of his age, residence, qualifications for membership in the Club, and that he will conform to the requirements of membership if elected. The proposal must then be referred to the Executive Committee, and if upon examination they shall find the candidate to be eligible and worthy of membership, they shall order the question as to his admission to be submitted to the Club by ballot. If there be five votes in the negative, the candidate shall be rejected and shall not again be voted upon for twelve months after such rejection. But if the number of negative votes be less than five, the candidate shall be elected, but shall not be considered a member until he shall have paid the initiation fee and dues for the current year. Any failure to pay the initiation and dues within thirty days after the candidate has been notified of his election, except as provided in Section 8, shall work a forfeiture of all rights under said election, if the Executive Committee shall so determine.

No entry shall be made on the record of the rejection of any candidate.

Sec. 8.—Exchange of Members.*—Any member of any other society in the Association of Engineering Societies, in good standing, may become a member of this Club, when duly elected as prescribed in Section 7, without paying the initiation fee, and with a release from the annual dues for such period, not over one year, as he may show by certificate he has paid in advance in the society from which he comes; provided such society shall have conferred like privilege on members of this Club.

Sec. 9.—Resignation of Members.—Any member whose dues have been fully paid may withdraw from the Club by sending to the Secretary a written resignation. Non-payment of dues for one year or longer may be treated as equivalent to resignation, but before any member is dropped from the rolls for delinquency, he shall be entitled to not less than four weeks' notice, during which time he may discharge his dues and have his membership continued. The sending of the Journal to any member in arrears for three months or more may, by vote of the Executive Committee, be discontinued.

*The Boston, Cleveland, Kansas City, Minneapolis, St. Paul, Detroit, Denver and Montana Societies have adopted similar provisions.

Sec. 10.—Expulsion of members.—Upon the written request of five members, that, for cause stated, any member be expelled, the Executive Committee shall consider the matter, and if they deem it best, shall advise the member that his resignation will be accepted. He shall, however, have the right to demand and receive a copy of the charges against him, and shall have a reasonable time to present a written defense. The Executive Committee may then pass finally upon the matter, and if the resignation has not been tendered, or a satisfactory defense made, may, by an affirmative vote of four of their number, expel the member, in which case they shall only notify him and the Club of their action, and his name shall be at once dropped from the list of members.

Sec. 11.—Nomination of Officers.—The members present at the first meeting in November of each year, shall elect, by ballot, a nominating committee of five members. No member shall serve upon the nominating committee two consecutive years. The nominating committee shall select one candidate for each office for the ensuing year and report to the Club at the second meeting in November. A copy of the report of the nominating committee shall be mailed to each member not less than two days prior to the annual meeting. At the annual meeting, the names proposed by the nominating committee shall be placed in nomination. Additional nominations for any office may be made at the annual meeting, by written request, signed by five members. In the list of candidates for each office upon the ballots, the name proposed by the nominating committee shall stand first.

Sec. 12.—Letter Ballots.—All ballots for the annual election of officers and amendments to the Constitution shall be by letter, provided, however, that when a letter ballot for election of officers results in a tie vote for any of the offices, a second letter ballot shall not be taken, but the members present at the meeting when the result of the letter ballot is announced, shall elect, by ballot, one of the candidates receiving the tie vote.

The Secretary shall mail a notice to every member of the Club, stating the names of the candidates for office, or the proposed amendment to the Constitution, and also the exact time at which the vote will be counted. The time for counting, together with the details of the manner in which the letter ballot shall be carried out, shall be determined by the Executive Committee, provided, that no count be taken within less than seven days from the time the notice is mailed. On the day appointed the Executive Committee shall count the votes received, and announce the result to the Club at its next meeting. In the election of officers, the candidate receiving a plurality of the votes cast shall be declared elected. Vacancies in office shall be

filled by ballot at the first meeting after they occur, a plurality vote being sufficient to elect.

Sec. 13.—Parlimentary Standard.—"Roberts' Rules of Order" shall be the parlimentary standard on all points not covered by the Constitution and By-Laws.

Sec. 14.—Amendments.—These By-Laws may be amended by a two-thirds vote of members present at any meeting, provided notice of the proposed amendment shall have been mailed to every member at least one week before the vote thereon is taken.

ENTERTAINMENT FUND

Rules and Regulations Governing the Care, Maintenance and Disbursement of the Engineers' Entertainment Fund, Adopted October 7, 1896.

1. The Fund shall be known as the Engineers' Entertainment Fund.

2. The Engineers' Entertainment Fund shall be devoted solely to the entertainment of distinguished engineers visiting the city, whether in conventions, small parties, or singly.

3. The Fund shall be maintained as follows:

   a. By interest on deposits.

   b. By voluntary subscriptions.

   c. By contributions from the treasury of the Engineers' Club of St. Louis, whenever in the judgment of the Executive Committee such contributions may be necessary and expedient; provided, however, that such contributions in any one year shall not exceed an amount equal to fifty cents for each resident member.

   d. By special assessments, as provided in Section 2 of the By-Laws.

4. The Executive Committee of the Engineers' Club of St. Louis, shall have charge of the care, maintenance and disbursement of the Engineers' Entertainment Fund, subject to instructions from the Club when such action may be deemed necessary. Disbursements exceeding $100.00 must first have the approval of the Cluo.

5. The affirmative votes of three members of the Executive Committee shall be required before any entertainment is undertaken. In emergencies, however, when a meeting of the Committee is impracticable, the President of the Club, or in his absence the Vice-President, may authorize such entertainment.

6. Any member of the Club may recommend the entertainment of visiting engineers to the Executive Committee, accompanying such recommendation with sufficient evidence of the propriety of such action.

ASSOCIATION OF ENGINEERING SOCIETIES

Association of Engineering Societies.

The following Articles of Association were adopted at a meeting held in Chicago, December 4, 1880. At this meeting there were present representatives of the

Western Society of Engineers,
Civil Engineers' Club of Cleveland,
Engineers' Club of St. Louis,
and the
Boston Society of Civil Engineers
was represented by letter.

For the purpose of securing the benefits of closer union and the advancement of mutual interests, the engineering societies and clubs hereunto subscribing have agreed to the following:

ARTICLES OF ASSOCIATION

Articles of Association.

ARTICLE I.

Name and Object.

Name and Object.

The name of this Association shall be "The Association of Engineering Societies." Its primary object shall be to secure a joint publication of the papers and the transactions of the participating Societies.

ARTICLE II.

Organization.

Organization.

Section 1.—The affairs of the Association shall be conducted by a Board of Managers under such rules and By-Laws as they may determine, subject to the specific conditions of these articles. The Board shall consist of one representative from each Society of one hundred members or less, with one additional representative for each additional one hundred members, or fraction thereof over fifty. The members of the Board shall be appointed as each Society shall decide, and shall hold office until their successors are chosen.

Sec. 2.—The officers of the Board shall be a Chairman and Secretary, the latter of whom may be or may not be himself a member of the Board.

ARTICLE III.

Duties of Officers.

Duties of Officers.

Section 1.—The Chairman, in addition to his ordinary duties, shall countersign all bills and vouchers before payment and present an annual report of the transactions of the Board; which report, together with a synopsis of the other general transactions of the Board of interest to members, shall be published in the Journal of the Association.

Duties of Officers.

Sec. 2.—The Secretary shall be the active business agent of the Board and shall be appointed and removed at its pleasure. He shall receive a compensation for his services to be fixed from time to time by a two-thirds vote. He shall receive and take care of all manuscript copy and prepare it for the press, and attend to the forwarding of proof sheets and the proper printing and mailing of the publications. He shall have power, with the approval of any one member of the Board, to return manuscript to the author for correction if in bad condition, illegible or otherwise conspicuously deficient or unfit for publication. He shall certify to the correctness of all bills before transmitting them to the Chairman for counter-signature. He shall receive all fees and moneys paid to the Association and hold the same under such rules as the Board shall prescribe.

Publications.

ARTICLE IV.

Publications.

Section 1.—Each Society shall decide for itself what papers and transactions of its own it desires to have published, and shall forward the same to the Secretary.

Sec. 2.—Each Society shall notify the Secretary of the minimum number of copies of the joint publication which it desires to receive, and shall furnish a mailing list for the same from time to time. Copies ordered by any Society may be used as it shall see fit. Payments by each Society shall in general be in proportion to the number of copies ordered, subject to such modification of the same as the Board of Managers may decide, by a two-thirds vote, to be more equitable. Assessments shall be quarterly in advance, or otherwise, as directed by the Board.

Sec. 3.—The publications of the Association shall be open to public subscription and sale, and advertisements of an appropriate character shall be received, under regulations to be fixed by the Board.

Sec. 4.—The Board shall have authority to print with the joint publications such abstracts and translations from scientific and professional journals and society transactions as may be deemed of general interest and value.

Conditions of Participation.

ARTICLE V.

Conditions of Participation.

Section 1.—Any Society of Engineers may become a member of this Association by a majority vote of the Board of Managers, upon payment to the Secretary of an entrance fee of fifty cents for each active member, and certifying that these Articles of Association have been duly accepted by it. Other technical organizations may be admitted by a two-thirds vote of the Board, and payment and subscription as above.

Sec. 2.—Any Society may withdraw from this Association at the end of any fiscal year by giving three months' notice of such intention, and shall then be entitled to its fair proportion of any surplus in the treasury, or be responsible for its fair proportion of any deficit.

Conditions of Participation.

Sec. 3.—Any Society may, at the pleasure of the Board, be excluded from this Association for non-payment of dues after thirty days' notice from the Secretary that such payment is due.

ARTICLE VI.

Amendments.

Amendments.

These articles may be amended by a majority vote of the Board of Managers and subsequent approval by a two-thirds of the participating societies.

ARTICLE VII.

Time of Going Into Effect.

Time of Going Into Effect.

These articles shall go into effect whenever they shall have been ratified by three Societies, and members of the Board of Managers appointed. The Board shall then proceed to organize, and the entrance fee of fifty cents per member shall then become payable.

These articles were adopted by the several Societies upon the following dates:

Engineers' Club of St. Louis, January 5, 1881.
Civil Engineers' Club of Cleveland, January 8, 1881.
Boston Society of Civil Engineers, January 19, 1881.
Western Society of Engineers, April 5, 1881.

The Board of Managers was organized at Cleveland, January 11, 1881.

The following Societies have since certified their acceptance of the articles and have become members of the Association of Engineering Societies:

Engineers' Club of Minneapolis, July, 1884.
Civil Engineers' Society of St. Paul, December, 1884.
Engineers' Club of Kansas City, January, 1887.
Montana Society of Civil Engineers, April, 1888.
Wisconsin Polytechnic Society, June, 1892.
Denver Society of Civil Engineers, January 24, 1895.
Association of Engineers of Virginia, February 1, 1895.
Technical Society of the Pacific Coast, March 1, 1895.
Detroit Engineering Society, January, 1897.
Engineers' Society of Western New York, January, 1898.
Louisiana Engineering Society, September 15, 1898.
Engineers' Club of Cincinnati, January, 1899.

The Wisconsin Polytechnic Society withdrew from the Association in March, 1894.

Time of Going Into Effect.

The Western Society of Engineers withdrew in December, 1895.

The Engineers' Club of Kansas City disbanded at the close of 1896.

The Denver Society of Civil Engineers and the Association of Engineers of Virginia disbanded in 1898.

Library of Engineers' Club.

LIBRARY OF ENGINEERS' CLUB

A complete "Author" and "Subject" index has been made by an expert, and is accessible to the Club members in the form of a card catalogue at the Club rooms.

Rules for the Use of the Library.

1. All new books and periodicals shall be kept on the table for one month and then shall be filed.
2. No book or periodical shall be taken from the Club rooms within one month of its receipt.
3. No book shall be kept out longer than one week. At the end of that time it must be returned, but may be taken out again if there is no call for it on record.
4. Any member taking books from the Club rooms must enter same with date of issue and return, against his name in the record book.
5. Members wishing any book which is out, may place a request on file in a record kept for that purpose, and shall be entitled to the book in the order of the names on record.

Additions to the Library During the Years 1901, 1902 and 1903.

Additions to the Library During the Years 1901, 1902 and 1903.

The Transition Curve.—Crandell.

Manual of Steam Boilers.—Thurston.

Design of Masonry Dams.—Wegman.

University of Texas Mineral Survey, Bulletins 4 and 5, 1902.

Theoretical Elements of Electrical Engineering.—Steinmetz.

The Prevention of Smoke.—W. C. Popplewell.

Hydraulics.—Merriman.

Applied Mechanics.—G. Lanza.

The Law of Contracts.—J. C. Wait.

Steam Boiler Economy.—Wm. Kent.

Cooper's Specifications for Steel Highway and Electric Railway Bridges and Viaducts, 1901.

Cooper's Specifications for Steel Railroad Bridges, 1901.

Cooper's Specifications for Foundations and Substructures of Highway and Electric Railway Bridges, 1902.

Retaining Walls for Earth.—M. A. Howe.

Mechanism and Equilibrium of Kites.—C. F. Marvin.

Kite Experiments at the U. S. Weather Bureau.—C. F. Marvin.

Trautwine's Civil Engineers Pocket Book, 1903.

Dynamo Electric Machines.—A. E. Wiener.

Report of the International Universal Exposition, Paris, 1900, Vols. 1, 2, 3, 4, 5, 6.

Boston Transit Commission, Annual Reports, 1901, 1902, 1903.

U. S. Commission of Education, Vols. 1 and 2, 1900; Vols. 1 and 2, 1901; Vols. 1 and 2, 1902.

Report Massachusetts State Board of Health, 1900, 1901, 1902.

Report U. S. Watertown Arsenal Tests of Iron, Steel and Other Metals, Vol. 2.

City Lighting Department, St. Louis, Annual Reports, 1901 and 1902.

Local Industries of Glasgow and West of Scotland.—A. McLean.

Reports U. S. Chief of Engineers, 1899-1900; Vols. 1, 2, 3, 4, 5 and Supplement, 1901; Vols. 1, 2, 3, 4 and supplement, 1902; three volumes of Index, 1866-1900.

U. S. Civil Service Commission, 17th and 18th Annual Reports, 1900, 1901.

Water Commissioner of St. Louis, Annual Report, 1902.

U. S. Coast and Geodetic Survey, Annual Reports, 1900, 1901, 1902; Special Reports, 1901, 1902.

Reports Metropolitan Water Board of Boston, 1901, 1902.

U. S. Department of Agriculture, Field Operation of Division of Soils, Report, 1899.

U. S. Geological Survey, 1899-1900, 21st Annual Report.

Proceedings of the Engineers' Congress at Glasgow, 1901, Vols. 1 and 2.

Engineering Index, Vol. 3, 1896-1900.

Masonry Construction.—I. O. Baker.

Combustion of Fuel and Prevention of Smoke.—W. M. Barr.

Irrigation Institutions.—Mead.

Rules for Railway Location and Construction.—E. H. McHenry.

Practical Electric Railway Handbook.—A. B. Herrick.

Separate System of Sewerage.—Staley & Pierson.

Steam Heating and Ventilation.—W. S. Monroe.

Mechanics of Engineering, Vols. 1 and 2. —A. J. DuBois.

Sewerage.—A. P. Folwell.

Mechanical Engineers' Pocket Book.—H. H. Suplee.

Mechanical Engineers' Hand Book.—Kent.

Electrical Engineers' Hand Book.—H. A. Foster.

Gas Engines.—F. R. Hutton.

Iron, Steel and Other Alloys.—H. M. Howe.

Building and Structures of American Railroads.—W. G. Berg.

Architectural Engineering.—Freitag.

Engineering for Land Drainage.—Elliot.

Designing of Draw Spans.—Wright.

Towers and Tanks for Water Works.—Hazlehurst.

Steel.—Metcalf.

Additions to the Library During the Years 1901, 1902 and 1903.

Proceedings of American Water Works Association, 1901, 1902, 1903.

Illinois Bureau of Labor Statistics, 20th Annual Coal Report, 1901.

U. S. Board Geographical Names, 2d Report, 1890-1899.

Transactions, Liverpool Engineers' Society, Vol. 21, 1900.

U. S. Corps, Engineers' Professional Papers, No. 28.

Department of Interior, Irrigation Papers, No. 66 and 70, 1902; Irrigation System of Texas, 1902; Report of Bureau of Education, Art and Industry.

House Documents, Vols. 10 and 13, 56th Congress, containing Report of Chief of Engineers, 1899-1900.

Annual Report, Brig.-Gen. Wm. Ludlow, Military Governor Habana, 1899-1900.

Official Classification of Exhibits, World's Fair, St. Louis, 1904.

Testing Hydraulic Cements, Report of Board of U. S. Engineers, 1901.

Baldwin on Heating (Revised edition).

Latham's Sanitary Engineering.

Tests of Arches, Austrian Society Engineers and Architects.

The Forth Bridge.

Die Bauwerke der Berliner Stadt.—Eisenbahn.

Mittheilungen der Anstadt zur Prufung von Baumaterialien.

All regular numbers of all Society Proceedings, etc.

Periodicals.

PERIODICALS.

The following Periodicals are received, but not bound:

Age of Steel.
American Electrician.
American Engineer.
Builder.
Clay Record.
Clay Worker.
Construction News.
Electrical Review.
Engineering Ass'n of the South, Quarterly.
Street Railway Journal.
Power and Transmission.
Engineer (Cleveland).
Mines and Minerals.
Official Gazette, U. S. Patent Office.
Power.
Public Improvements.
The Lumberman.
Travel.
Western Electrician.
Railway and Engineering Review.
Telephony.

The following are received and bound for permanent record:

American Machinist, Vols. 19-26, 1896-1903.
Cassier's Magazine, Vols. 2-24, 1892-1903.
Electrical World and Engineer, Vols. 9-42, 1887-1903.
Engineering and Mining Journal, Vols. 55-76, 1893-1903.
Engineering Magazine, Vols. 1-25, 1891-1903.
Engineering News, Vols. 2, 4, 5-50, 1875, 1877, 1878-1903.
Engineering Record, Vols. 1-48, 1877-1903.
Engineering Review, Vols. 6-13, 1896-1903.
Railroad Gazette, Vols. 4-35, 1872-1903.
The Engineer, London, Vols. 15-20, 26, 1862-5, 1868, and Vols. 81-96, 1896-1903.

PROCEEDINGS AND TRANSACTIONS OF SOCIETIES

American Society of Civil Engineers, Transactions, Vols. 1-51, 1867-1903.

American Society of Mechanical Engineers, Transactions, Vols. 1-24, 1880-1903.

American Institute of Electrical Engineers, Transactions, Vols. 9-19, 1892-1903.

American Institute of Mining Engineers, Transactions, Vols. 2, 5, 6, 14-33, 1885-1903.

Association of Engineering Societies, Journal, Vols. 1-31, 1881-1903.

Institution of Civil Engineers, London, England, Minutes of Proceedings, Vols. 59-154, 1879-1903.

Liverpool Engineering Society, Proceedings, Vols. 1-8, 12-22, 1881-88, 1891-1902.

Engineers' Club, Philadelphia, Proceedings, Vol. 1, Nos. 1 and 5; Vols. 3 and 4; Vol. 5, Nos. 1 and 4; Vols. 6-20; 1879-1903.

Engineers' Society of Western Pennsylvania, Proceedings, Vols. 1, 5-19, 1880-1903.

Western Society of Engineers, Journal, Vols. 1-8, 1896-1903.

Technology Quarterly (Massachusetts Institute of Technology), Vols. 1-12, 1887-99.

New England Water Works Association, Proceedings, Vols. 2-10, 1887-96, 5 Vols.

American Water Works Association, Proceedings of Annual Meetings, Vols. 5-23, 1885-1903.

SUMMARY TABLE OF STATISTICS OF ENGINEERS' CLUB OF ST. LOUIS.

Year.	Meetings. Years.	Meetings. Total.	President.	Vice-President.	Secretary.	Treasurer.	Librarian.	Members.	Average Attendance.
1868	9	9			G. P. Herthel, Jr.	J. P. Davis.			
1869	52	61	Henry Flad.	F. E. Shickle.	" "	" "			
1870	36	97	" "	" "	" "	T. J. Whitman.			
1871	28	125	" "	" "	L. F. Rice.	William Wise.			
1872	21	146	" "	" "	C. A. Smith.	" "			
1873	13	159	" "	" "	" "	" "			
1874	8	167	" "	G. W. Fisher.	" "	" "			
1875	2	169	" "	" "	" "	" "			
1876	3	172	" "	" "	" "	" "			
1877	4	176	" "	" "	" "	" "			
1878	11	187	" "	T. J. Whitman.	" "	" "			
1879	5	192	" "	" "	" "	" "			
1880	11	203	" "	" "	" "	" "			
1881	8	211	T. J. Whitman.	C. S. Smith.	" "	E. D. Meier.			
1882	5	216	C. S. Smith.	William Wise.	" "	" "			
1883	4	220	H. C. Moore.		J. B. Johnson.	" "			12
1884	18	238	C. M. Woodward.	Robert Moore.	" "	" "		106	23
1885	17	255	Robert Moore.	R. E. McMath.	T. D. Miller.	M. L. Holman.	J. B. Johnson.	120	25
1886	14	269	R. E. McMath.	W. B. Potter.	" "	" "	" "	120	19
1887	14	283	W. B. Potter.	M. L. Holman.	W. H. Bryan.	C. W. Melcher.	" "	133	21
1888	15	298	M. L. Holman.	J. A. Ockerson. E. D. Meier.	" "	" "	" "	150	28
1889	18	316	E. D. Meier.	F. E. Nipher.	" "	" "	W. H. Bryan.	164	30
1890	22	338	F. E. Nipher.	Geo. Burnet.	" "	" "	J. B. Johnson.	179	30
1891	18	356	Geo. Burnet.	N. W. Eayrs. J. B. Johnson.	A. Thacher.	" "	" " R. E. McMath.	177	28
1892	18	374	J. B. Johnson.	B. L. Crosby.	" "	" "	" "	186	29
1893	16	390	Robert Moore.	" "	" "	" "	" "	180	26
1894	18	408	B. L. Crosby.	S. B. Russell.	W. H. Bryan.	T. B. McMath.	T. L. Condron.	179	30
1895	19	427	S. B. Russell.	J. A. Ockerson.	" "	" "	J. N. Judson. W. A. Layman.	181	22
1896	18	445	J. A. Ockerson.	Edward Flad.	" "	" "	" "	182	23½
1897	18	463	Edward Flad.	W. H. Bryan.	R. McCulloch.	" "	Julius Baier.	186	27½
1898	18	481	W. H. Bryan.	B. H. Colby.	" "	" "	E. J. Jolly.	201	29½
1899	18	499	B. H. Colby.	F. E. Nipher.	E. R. Fish.	" "	" "	200	28½
1900	18	517	W. S. Chaplin.	E. J. Spencer.	F. E. Bausch.	E. R. Fish.	J. L. Van Ornum.	204	27
1901	18	535	E. J. Spencer.	J. H. Kinealy.	W. J. Brennecke.		" "	215	29
1902	18	553	J. H. Kinealy.	J. L. Van Ornum.	D. W. Roper.	Geo. I. Bouton. E. E. Wall.	E. B. Fay.	221	30
1903	18	571	J. L. Van Ornum.	J. A. Ockerson.	H. J. Pfeifer.	" "	" "	233	27
1904	.....	.....	J. A. Ockerson.	Robert Moore.	R. H. Fernald.	" "	" "	.....	.....

MEMBERS OF THE ENGINEERS' CLUB OF ST. LOUIS.

CORRECTED TO JUNE 1, 1904.

(—) Date of Election to Membership.

RESIDENT MEMBERS.

ABBOTT, FREDERICK W. (January 2, 1889), 620 Chestnut Street.
President, Abbott-Gamble Construction Co.

ADLER, FRANK T. (October 1, 1902), 2336 Whittemore Place.
Engineer and Surveyor, Street Department.

ANGELL, JOHN E. (April 14, 1900), Laclede Building.

BAKER, VERNON (October 20, 1897), 417 Pine Street.
Civil Engineer.

BARNS, WILLIAM EDDY (February 19, 1890), Fullerton Building.

BARTLETT, ROY (February 18, 1903), 3021 Eads Avenue.
Assistant to William H. Bryan, Consulting Engineer.

BARWICK, OLIVER JAMES (September 20, 1889), 312 Wainwright Building, General Contractor.

BARRY, MARK (December 7, 1898), 1305 Chemical Building.
Engineer with H. H. Humphrey, Consulting Engineer.

BAUSCH, FREDERICK EMIL (January 2, 1895), 1416 Chemical Bldg.
Manager, St. Louis office, Hooven, Owens, Rentschler Co.

BEARDSLEE, FRANK DIXON (October 4, 1899), 415 Locust Street.
Contracting Agent, Union Electric Light & Power Co.

BENDIT, LOUIS (March 6, 1901), 714 Wainwright Building.
President, Laufketter-Bendit Mechanical Engineering Co.

BONSACK, ARTHUR A. (March 2, 1904), 1007 Fullerton Building.
St. Louis Manager, Ingersoll, Sergeant Drill Co.

BORDEN, ALBERT (April 15, 1896), 808 Mermod & Jaccard Building.
Civil Engineer.

BOUTON, WILLIAM (February 13, 1884), 2909 Park Avenue.
Vice-President, Pitsman's Co. of Surveyors and Engineers.

BOWEN, SHERMAN WORCESTER (January 21, 1904), 5945 Cote Brilliante Avenue; Assistant Engineer with Brenneke & Fay.

BRENNEKE, WILLIAM GEORGE (April 4, 1894), 1009 Fullerton Building; Brenneke & Fay, Consulting Engineers.

BRODERICK, JAMES R. (January 21, 1903), 5172 Fairmount Avenue.
Structural Engineer.

BRUNER, PRESTON MARTIN (February 18, 1885), Odd Fellows' Building; Contractor for Concrete Work.

BRUSSEL, HUGHES (March 18, 1903), 303 Benoist Building.
Representive, Hennibique System of Armored Concrete Constr'n.

BRYAN, WILLIAM HENRY (January 30, 1884), 329 Lincoln Trust Building; Consulting, Mechanical and Electrical Engineer.

BURGESS, ROBERT (February 17, 1892), 2147 Clifton Avenue.
Locating Engineer, Frisco System.

CAMPBELL, JOHN LOGAN (January 21, 1903), 910 Security Bldg.
Chief Engineer, Gasconade Railway Construction Company.

CANTLIN, ALBERT H. S. (October 1, 1902), 817 Wainwright Building,
Electric Storage Battery Co.

CHAPHE, JAMES M. (January 20, 1886), 3016 Sheridan Avenue.

CHAPLIN, WINFIELD SCOTT (March 16, 1892), Washington University; Chancellor of Washington University.

CHILDS, OLIVER W. (March 16, 1898), 2301 South Seventh Street.
Chief Engineer, Stupp Bros. Bridge & Iron Co.

CLARK, CHARLES W. (February 4, 1885), Webster Groves, Mo.
Architect and U. S. Assistant Engineer.
COLBY, BRANCH HARRIS (December 18, 1889), 415 Locust Street.
Civil Engineer and Consulting Engineer.
COLE, BURT (January 22, 1902), 164 Laclede Building.
Chief Engineer, Consolidated Coal Co. and Western C. & M. Co.
COLNON, REDMOND STEPHEN (December 4, 1889), 127 Laclede Building; Contractor.
COMBER, WILLIAM GEORGE (February 5, 1896), 1115 Fullerton Bldg.
U. S. Assistant Engineer, Mississippi River Commission.
COOK, ABRAHAM (February 3, 1886), 4500 North Second Street.
Laclede Car Company.
CRECELIUS, LAWRENCE P. (February 4, 1903), 3138 S. Grand Ave.
Electrician, St. Louis Transit Co.
CUNNINGHAM, ANDREW O. (May 20, 1903), Lincoln Trust Building.
Bridge Engineer, Wabash Railroad.
CUTTS, FRANCIS T. (February 24, 1903), 5226 Washington Avenue.
Second Assistant Engineer of Distribution, St. Louis Water Works.
DAY, EDWARD B. (October 7, 1903), 610 Globe-Democrat Building.
Office Engineer, Burlington's Missouri Lines.
DICKE, EDWARD CHRISTIAN (January 16, 1901), 1909 Hebert St.
Assistant Engineer, Terminal Railroad Association.
DZIATZKO, LEO CHARLES (March 16, 1898), 2912 Ellendale Avenue.
General Manager, McMath Surveying Company.
EINSTEIN, ROBERT E. (March 19, 1902), 5024 Fairmount Avenue.
Engineer, Elliot Frog and Switch Co.
FAY, EDWARD BAYRD (March 21, 1894), 1009 Fullerton Building.
Brenneke & Fay, Consulting Civil Engineers.
FERNALD, ROBERT HEYWOOD (January 7, 1903), Washington University; Professor of Mechanical Engineering.
FIELD, EDWARD (April 15, 1903), 4762 LeDuc Street.
Salesman of Corliss Engines, St. Louis Iron and Machine Works.
FINLEY, EDWIN C. (February 18, 1903), World's Fair Station.
Engineer of Railroads, Louisiana Purchase Exposition.
FISCHER, CHARLES OWEN (October 3, 1894), 2710 S. Compton Ave.
Secretary, Pitzman's Company of Surveyors and Engineers.
FISH, EDWARD RUSSELL (May 6, 1896), 4240 Cleveland Avenue.
Secretary, Heine Safety Boiler Co.
FISHER, SAMUEL B. (May 18, 1898), 406 Wainwright Building.
Chief Engineer, M., K. & T. R'y.
FLAD, EDWARD (January 16, 1884), 1009 Fullerton Building.
Consulting Engineer.
FOGARTY, WILLIAM J. (October 4, 1899), 4266 Flad Avenue.
Manager, Magnatite Foundry Co.
FRENCH, GEORGE HARRISON (February 15, 1899), 1115 Fullerton Building; U. S. Asst. Engineer with Mississippi River Commission.
GARCIA, JOHN A. (May 20, 1903), 3109 South Grand Avenue.
Mining Engineer, Missouri Pacific Coal Co.
GARRELS, WILLIAM LOUIS (May 7, 1897), 4531 West Pine Boulevard.
Consulting Engineer.
GAYLER, CARL (December 5, 1877), City Hall.
Bridge Engineer, Street Department.
GOODALE, LOOMIS F. (September 20, 1902), 610 Globe-Democrat Bldg.
Chief Engineer, Burlington Route.
GOODWIN, PHILIP ROSS (February 3, 1904), Washington University.
Instructor, Civil Engineering Department.
GRAVES, WILLIAM NELSON (December 2, 1896), 2813 Lafayette Ave.
General Supt. and Mechanical Engineer, Hydraulic Press Brick Co.
GREENSFELDER, ALBERT P. (September 17, 1902), 206 Union Station.
Assistant Engineer, Terminal Railroad Association.

GRONEMANN, HENRY (February 6, 1899), 2719 Stoddard Street.
HAND, WILLIAM M. (February 19, 1902), 816 Wainwright Building.
Engineering Department, General Electric Co.
HANNA, JOHN V. (October 7, 1903), Care Frisco System.
Principal Assistant Engineer, Frisco System.
HARTING, OTTO F. (March 18, 1903), 5707 Florissant Avenue.
Assistant Engineer, Portland Cement Co.
HAZARD, ALBERT B. (October 5, 1898), 615 North Second Street.
Manufacturer of Diamond Drilling Machinery.
HENBY, WILLIAM HASTINGS (March 6, 1901), 312 City Hall.
Assistant Engineer, St. Louis Water Works.
HERMANN, EDWARD A. (May 20, 1891), 812 Security Building.
Consulting Civil Engineer.
HILL, JOHN (April 20, 1898), Wainwright Building.
President, Hill-O'Meara Construction Co.
HINCKLEY, JOHN FRANKLIN (November 4, 1903), 800 Fullerton Building; Chief Engineer of Construction, Frisco System.
HOLMAN, MINARD LA FEVER (February 6, 1878), 3744 Finney Ave.
General Superintendent, Union Electric Light and Power Co.
HUMPHREY, HENRY H. (October 21, 1891), 1305 Chemical Building.
Consulting Electrical Engineer.
HUNICKE, WILLIAM A. (October 20, 1897), 2937 Henrietta Street.
Civil Engineer.
INGOLDSBY, FRANK S. (February 20, 1899), Chemical Building.
Vice-President and General Manager, Ingoldsby Automatic Car Co.
JACOBSEN, KNUD HENRIK (March 2, 1904), 502 Mo. Pac. Building.
Draftsman, Bridge Department, Missouri Pacific Railway.
JENNINGS, JAMES G. (June 4, 1890), City Hall.
Engineer of Construction and Re-Construction, Street Department.
JOHNSON, ALBERT L. (March 20, 1889), 606 Century Building.
Engineer, St. Louis Expanded Metal Fireproofing Co.
JOHNSON, GEORGE DYER (January 2, 1901), 3938A North 11th St.
Superintendent, Mississippi Glass Co.
JOHNSON, RENO DE ORVILLE (December 7, 1887), 623 Roe Building.
Consulting Mining Engineer.
JOLLEY, EDWIN JAMES (November 2, 1892), 1119 Bayard Avenue.
Engineer of Grades, Street Department.
JONES, CHARLES E. (May 21, 1884), Manual Training School.
Instructor in Forging, and Engineer of Steam Plant.
JUST, HENNING HANS (March 18, 1903), Missouri Pacific Building.
Bridge and Structural Draftsman, Missouri Pacific Railway.
KESSLER, J. J. (April 16, 1902), 224 South Vandeventer Avenue.
Engineer of Tests.
KOKEN, ERNEST C. F. (May 15, 1901), 3522 Hawthorne Boulevard.
Secretary, Banner Iron Works.
KRUTZSCH, HERMAN (March 20, 1889), 3863 Cleveland Avenue.
Vice-President and Manager, St. Louis Iron & Machine Works.
LAIRD, JOHN A. (November 16, 1887), Chemical Building.
Chief Engineer, Cupples Station, and Consulting Engineer.
LANGSDORF, ALEXANDER S. (October 16, 1901), Washington University; Assistant Professor of Electrical Engineering.
LAYMAN, WALDO ARNOLD (January 2, 1895), 2017 Locust Street.
General Manager, Wagner Electric Manufacturing Co.
LEIGHTON, GEORGE B. (April 3, 1895), 8th and Locust Streets.
President, Leighton & Howard Steel Co.
LICHTER, JOHN J. (June 19, 1895), 1318 Chemical Building.
Lichter & Jens, Consulting Civil, Mechanical and Electrical Eng'r.
MacCARTHY, D. EDWARD (October 1, 1902), 2102 Wash Street.
Superintendent, American Arithmometer Co.

McMATH, ROBERT E. (March 3, 1880), 328 Lincoln Trust Building.
Consulting Engineer.

MARKMANN, PHILIP J. (April 2, 1902), 1211A Missouri Avenue.
Structural Engineer.

MEINHOLTZ, HERMAN C. (May 6, 1896), 4812 Greer Avenue.
Superintendent, Heine Safety Boiler Co.

MERSEREAU, CHARLES V. (February 13, 1884), 3838 Shenandoah Ave.
Assistant Engineer, Water Works Extension.

MESTON, THOMAS M. (January 7, 1903), 2030 Washington Avenue.
Secretary, Emerson Electric Manufacturing Co.

METZGER, LOUIS C. F. (November 5, 1902), 1008 Hickory Street.
Draftsman, Missouri Pacific Railway.

MITCHELL, WILLIAM S. (November 19, 1884), Custom House.
Assistant Engineer, Improvement Mississippi River between Missouri and Ohio Rivers.

MOGENSEN, OLAF E. (February 18, 1903), 502 Missouri Pacific Bldg.
Structural Engineer, Missouri Pacific System.

MOORE, PHILIP NORTH (April 23, 1873), 121 Laclede Building.
Consulting Mining Engineer; President, Tecumseh Iron Co.; Treasurer, Rose Run Iron Co. of Kentucky.

MOORE, ROBERT (April 23, 1873), Laclede Building.
Consulting Engineer.

MORENO, CHARLES ALBERT (February 4, 1903), 3901 Park Avenue.
Chief Engineer, St. Louis Transit Company.

MOREY, RICHARD (November 20, 1895), Equitable Building.
Vice-President and General Manager, Morey Engineering and Constructing Co.

MORRISON, HERBERT HUNT (February 3, 1904), Board of Education Building; Chief Engineer, Board of Education.

MOULTON, JULIUS (May 10, 1876), 305 City Hall.
Civil Engineer, Harbor and Wharf Department.

MUNDY, WILLIAM O. (February 4, 1903), Park and Vandeventer Avs.
Master Mechanic, St. Louis Transit Co.

MURPHY, R. LINCOLN (January 7, 1903), 606 Century Building.
Asst. Engineer, St. Louis Expanded Metal and Fireproofing Co.

NORTH, ARTHUR T. (June 5, 1901), 302 Fullerton Building.
Warren, Webster & Co.

NORTON, GUY TYLER (May 7, 1902), 2644 Nebraska Avenue.
Engineer and Architect, Wm. J. Lemp Brewing Co.

OCKERSON, JOHN AUGUSTUS (April 9, 1884), 1119 Fullerton Bldg.
Civil Engineer; Member Mississippi River Commission; Director, Liberal Arts Department, Louisiana Purchase Exposition Co.

O'REILLY, ANDREW J. (March 4, 1891), 1507 Papin Street.

PARKER, EDGAR CHARLES (February 15, 1888), 1019 Chemical Bldg.
Vice-President and Treasurer, Steam Appliance and Supply Co.

PARKER, LEMON (January 2, 1889), 3413 Oak Hill Avenue.
Secretary and Superintendent, Parker-Russell M. & M. Co.

PARKER, RUSSELL (April 4, 1888), 3405 Oak Hill Avenue.
Chemist, Parker-Russell Mining and Manufacturing Co.

PERKINS, NATHAN W., Jr. (April 9, 1884), 4446 Page Boulevard.
Mechanical Engineer.

PETERS, THOMAS K. (January 8, 1902), Chemical Building.
Thomas K. Peters Construction Co.

PFEIFER, HERMAN J. (February 3, 1897), 4153 Cleveland Avenue.
General Superintendent of Construction, Street Department.

PHILLIPS, HIRAM (April 5, 1899), City Hall.
President, Board of Public Improvements.

PHILLIPS, RICHARD HARVEY (March 15, 1899), 5147 Vernon Ave.
Chief Engineer, Louisiana Purchase Exposition Co.

PITZMAN, JULIUS (March 5, 1890), 615 Chestnut Street.
Street Improvement, Landscape Work and Surveying.
POST, TRUMAN M. (March 6, 1901), 5678 Cabanne Avenue.
Mechanical Draftsman, Mississippi River Commission.
PURDON, CHARLES D. (October 16, 1901), Frisco Building.
Engineer, Maintenance of Way, Frisco System.
REBER, H. LINCOLN (January 3, 1894), Century Building.
Secretary and General Manager, Kinloch Telephone Co.
REED, ALVIN D. (January 8, 1902), 3126 Rutger Street.
REEVES, WILLIAM HENRY (March 17, 1897), 317 North 9th Street.
St. Louis Manager, Henry R. Worthington.
RINGER, FRANK (October 4, 1899), 406 Wainwright Building.
Assistant Engineer, M., K. & T. R'y.
ROBINSON, JOHN C. (January 23, 1902), 6017 West Cabanne Avenue.
Secretary and Treasurer, St. Louis Portland Cement Works.
ROEHRIG, CHARLES W. (October 16, 1901), 2856 Russell Avenue.
Civil Engineer.
ROHWER, HENRY (May 20, 1903), 5900 Clemens Avenue.
Chief Engineer, Missouri Pacific System.
ROLFE, WILLIAM E. (November 4, 1903), 312 City Hall.
Engineer of Distribution, Water Department.
ROSENTHAL, GEORGE D. (February 19, 1902), 816 Wainwright Bldg.
Manager, St. Louis office of the General Electric Co.
RUCKERT, LOUIS (January 18, 1889), 3023 Shenandoah Avenue.
Dealer in Drawing Materials.
RUSSELL, S. BENT (February 13, 1884), 417 Pine Street.
Consulting Civil Engineer.
RUSTIN, HENRY (March 19, 1902), World's Fair.
Chief Electrical and Mechanical Engineer, Louisiana Purchase Exposition Co.
SCHAUMLEFFEL, PETER W. (November 16, 1887), 2329 Whittemore Place; Superintendent, St. Louis Lead and Oil Co.
SCHMITZ, OTTO (February 16, 1887), 2114 South Compton Avenue.
Civil Engineer, with Julius Pitzman.
SCHWEDTMANN, FERDINAND (November 17, 1897), Chemical Bldg.
Ruebel, Schwedtmann & Wells, Consulting Electrical and Mechanical Engineers.
SIEBERT, ALFRED (October 2, 1895), 4950 Columbia Avenue.
Consulting Engineer and Refrigerating Expert.
SPENCER, EUGENE J. (March 16, 1894), 24 Laclede Bu..ding.
Consulting Engineer.
STOLBERG, EMIL CHARLES (October 28, 1897), 3936 Shaw Avenue.
Mechanical and Electrical Dept., Louisiana Purchase Exposition.
SWOPE, GERARD (October 17, 1900), 810 Spruce Street.
Electrical Engineer, and St. Louis Representative of the Western Electric Co.
TATE, RODERICK H. (October 16, 1901), 1368 Granville Place.
Mechanical Superintendent, St. Louis Refrigerator and Cold Storage Co.
THACHER, ARTHUR (February 16, 1887), 4304 Washington Avenue.
President and Manager, Central Lead Co., and President of the Renault Lead Co.
TIDEMANN, HENRY G. (February 27, 1884), 1726 Mississippi Avenue.
Mechanical Engineer, Heine Safety Boiler Co.
TOENSFELDT, HANS CARL (June 5, 1901), 1550 Mississippi Avenue.
Assistant Engineer with Brenneke & Fay.
TRAVILLA, JAMES C. (November 6, 1901), 2038 Blendon Place.
Office Superintendent, Street Department.
TREPP, SAMUEL (October 20, 1898), 4150 Westminster Place.
Mechanical Engineer, Mallinckrodt Chemical Works.

Members of the Engineers' Club of St. Louis.

TUCKER, CHARLES H. (October 3, 1900), 920 North First Street.
Secretary and Treasurer, A. Leschen & Sons Rope Co.

TURNER, O. H. B. (February 19, 1896), 700 Carleton Building.
Chief Engineer, New Mexico and Pacific Railroad.

TYRRELL, WARREN A. (November 21, 1900), 4308 Olive Street.
Civil Engineer.

URBAUER, HUGO F. (October 3, 1900), 1114 Pine Street.
President, Urbauer-Atwood Heating Co.

VAN ORNUM, JOHN LANE (February 5, 1896), Washington University; Professor of Civil Engineering.

VAN SANT, ROBERT L. (November 21, 1888), 55 Third National Bank Building; Engineer and Contractor.

VARRELMANN, CHARLES (November 26, 1884), City Hall.
Street Commissioner.

VELLA, LORENZO B. (November 4, 1903), 2725 Lucas Avenue.
District Engineer, Street Department.

VITERBO, LIONEL (May 18, 1904), 406 Benoist Building.
Engineer of The Jameton Construction Co.

VOSE, FRED HALE (February 3, 1904), Washington University.
Instructor, Mechanical Engineering.

WALKER, JOHN EDWARD (May 20, 1903), 512 Frisco Building.
Office Engineer, St. Louis, Kansas City & Colorado R. R.

WALL, EDWARD EVERETT (February 6, 1889), 77 E. May Street.
Principal Assistant Engineer, Water Works Extension.

WANGLER, JOSEPH F. (April 13, 1881), 1535 North Ninth Street.
Boiler Manufacturer.

WARREN, BERIAH (November 6, 1878), 1619 Pennsylvania Avenue.
General Superintendent, St. Louis, Troy & Eastern R. R.

WAY, SYLVESTER B. (May 17, 1899), 10th and St. Charles Streets.
Superintendent, Union Electric Light & Power Co.

WELLS, GEORGE E. (October 16, 1901), Chemical Building.
Ruebel, Schwedtmann & Wells, Consulting, Electrical and Mechanical Engineers.

WHEELER, HERBERT ALLEN (March 12, 1884), Chemical Building.
Consulting Mining Engineer.

WIEDERHOLDT, ERNEST F. (October 7, 1903), 1211 Morrison Ave.
Engineering Department, Burlington's Missouri Lines.

WILCOX, FRANK LESLIE (February 18, 1903), Boat House, World's Fair; Assistant Engineer, Louisiana Purchase Exposition.

WINN, WALTER E. (April 12, 1902), 724 Roe Building.

WISE, WILLIAM (Charter Member), 3203 Pine Street.
Civil Engineer.

YOUNG, CHARLES EVERETT (February 18, 1903), 809 Clarendon Av.
Engineer, Water, Sewer and Fire Protection, Louisiana Purchase Exposition.

ZELLE, WILLIAM CHARLES (January 16, 1901), 430 Lincoln Trust Building; Contractor.

ZELLER, ALBERT HENRY (December 7, 1887), 1009 Fullerton Bldg.
Civil Engineer.

Non-Resident Members.

NON-RESIDENT MEMBERS.

AFFLECK, B. F. (November 6, 1901), Chicago, Ill.
Cement Department, Illinois Steel Co.

ASHBURNER, THOMAS (April 17, 1895), 1215 Marquette Bldg., Chicago, Ill.; Agent, Babcock & Wilcock Co.

AXTELL, FRANK FOYE (March 20, 1899), Sabine, Tex.
With Corps of Engineers, United States Army.

BAIER, JULIUS (February 3, 1886), Ruby, Montana.
Manager, Conrey Placer Mining Co.

BARTH, CARL G. (November 20, 1895), Swarthmore, Penn.
Consulting Engineer.

BASCOME, WESTERN R. (November 6, 1889), 11 W. 25th Street, New York City; Asst. Engineer in charge of Vernon Ave. Bridge, Long Island City, N. Y .

BILHARZ, OSCAR M. C. (October 4, 1899), Flat River, Mo. Assistant Superintent, St. Joseph Lead Co.; Superintendent of Mines, Doe Run Lead Co.

BLAISDELL, ANTHONY H. (March 3, 1880), Coeymans, Albany Co., New York.

BOUTON, GEORGE I. (October 20, 1897), Room 1152, 11 Broadway, New York City.; Engineer, Heine Safety Boiler Co.

BOYD, ALFRED (October 19, 1898), Cleveland, Ohio. With Wellman, Siever, Morgan Engineerning Co.

BOYER, JOSEPH (November 1, 1899), 637 Woodward Avenue, Detroit, Mich.; President, Boyer Machine Co.

BRANCH, HENRY (October 6, 1897), Tuscon, Arizona. Assistant Engineer, Pacific Electric Railway Co.

BRANNE, JOHN S. (May 18, 1898), 45 Broadway, New York City. Structural Engineer; Secretary, James E. Brooks Co., Consulting Engineers.

BROWN, WALTER S. (January 8, 1896), Milwaukee, Wis. Mechanical Engineer, Allis-Chalmers Co.

BRYAN, CHARLES W. (December 1, 1886), 100 Broadway, New York City; General Manager, American Bridge Company of New York.

BUTLER, LAWRENCE P. (November 18, 1891), Pitogo, Tayabas, Province, P. I. First Lieutenant, 41st Infantry, U. S. V.

CARL, LOVELL H. (October 5, 1898), 71 Broadway, New York City. General Sales Agent, Edicon Portland Cement Co.

CONNOR, EDWARD H. (February 15, 1888), Leavenworth, Kan. Engineer, Missouri Valley Bridge and Iron Works.

CROSBY, BENJAMIN L. (February 5, 1890), 1213 Charles Street, St. Joseph, Mo.; Auditor, Burlington's Missouri Lines.

DAVIS, CHARLES HENRY (October 3, 1900), 25 Broad Street, New York City; Civil Engineer.

DEAN, JOHN (October 23, 1899), 3624 Forest Avenue, Chicago, Ill. Civil Engineer and Contractor.

DUN, JAMES (January 22, 1890), 1602 Great Northern Building, Chicago, Ill.; Chief Engineer, A., T. & S. F. R'y System.

DUNAWAY, HORACE (February 5, 1896), U. S. Engineer's Office, St. Paul, Minn.; U. S. Surveyor.

FAUST, FRANK CORIDON (May 17, 1899), Red Fork, I. T. Division Engineer, Arkansas Valley and Western R. R.

FERGUSON, OSCAR W. (January 2, 1899), Washington, D. C. Assistant Engineer, U. S. Coast and Geodetic Survey.

FOSTER, CHARLES F. (May 7, 1884), 7058 Eggleston Ave., Chicago, Ill.; Mechanical Engineer.

FREEMAN, STUART E. (November 6, 1895), Barberton, Ohio. Superintendent, National Drill and Manufacturing Co.

GOULD, WILLIAM T. (May 16, 1888), Dobb's Ferry, New York. Engineer with B. H. R. R. Co. and B. R. T. Co.

GUINN, JOHN BROOME (January 5, 1898), 416 Joplin Street, Joplin, Mo.; Consulting Mining Engineer and General Manager Guinn Lead and Zinc Properties.

HAMMOND, ALONZO J. (February 7, 1894), South Bend, Ind. City Engineer.

HAWKES, CHARLES W. (October 6, 1897), 308 East Grand Avenue, Springfield, Ill.; Manager, Springfield Boiler and Manufacturing Co.

HELM, EDWIN GUY (January 7, 1903), City Hall, East St. Louis, Ill. Civil and Consulting Engineer.

HENDRICKS, VICTOR K. (March 1, 1899), 111 W. Saratoga Street, Baltimore, Md.

Non-Resident Members.

HOWE, MALVERD A. (January, 18, 1888), 2108 N. 10th Street, Terre Haute, Ind.; Professor of Civil Engineering, Rose Polytechnic Institute.

HUTCHINSON, CARY T. (April 20, 1898), 56 Pine Street, New York City, Consulting Electrical Engineer.

JEWETT, ELIOT C. (June 18, 1884), Fundicion No. 2, Monterey, Mex. Mining Engineer with Cia. Minera, Fundidora y Afinadora.

KINEALY, JOHN HENRY (December 16, 1885), 1107 Pemberton Building, Boston, Mass.; Consulting Engineer.

KLAUDER, RUDOLPH H. (April 17, 1901), 41 Phil-Ellena Street, Philadelphia, Pa.

LEONARD, EDWARD F. (December 19, 1883), Springfield, Ill. President, Toledo, Peoria & Western Railway Co.

LUBBERGER, FRITZ (December 4, 1901), Morgan and Van Buren Streets, Chicago, Ill.; Electrical Engineer, Automatic Electrical Co.

McCULLOCH, RICHARD (November 15, 1893), 2020 State Street, Chicago, Ill.; Assistant General Manager, Chicago City R'y Co.

McMATH, THOMAS B. (November 4, 1885), Claypole Building, Indianapolis, Ind.; Engineer, Indianapolis Traction and Terminal Co.

MALTY, FRANK B. (October 4, 1893), Memphis, Tenn. Superintendent of Dredging Operations, Mississippi River Comm.

MEIER, EDWARD D. (January 3, 1872), 11 Broadway, New York City. President and Chief Engineer, Heine Safety Boiler Co.

MELCHER, CHARLES W. (March 4, 1883), 84 Van Buren Street, Chicago, Ill.; Western Manager, Ingersoll-Sergeant Drill Co.

MILNER, BENJAMIN C. (October 17, 1901), 915 Columbia Building, Louisville, Ky.; Superintendent, St. Louis-Louisville Lines, Southern Railway Co.

MITCHELL, CHARLES DWIGHT (April 4, 1894), Cotter, Ark. Contractor.

MITCHELL, MARCUS L. (February 7, 1894), Manila, P. I. Chief Engineer, Insular Government Ice Plant.

MONELL, JOSEPH T. (May 27, 1885), Flat River, Mo. Superintendent, Central Lead Co.

MONTGOMERY, GEORGE S. (January 6, 1897), 620 Bryant Building, Kansas City, Mo.; Manager, Kansas City Office, Otis Elevator Co.

MOORSHEAD, THOMAS C. (January 22, 1902), Alton, Ill. Chief Engineer, Illinois Terminal Railway.

NEFF, WILLIAM A., Jr. (March 5, 1890), 1975 Doan Street, Cleveland, O.; European Agent, Forest City Electric Co.

PEGRAM, GEORGE H. (April 7, 1880), 195 Broadway, New York City. Chief Engineer, Manhattan Railway.

PERRINE, WILLIAM F. (January 21, 1903), Moberly, Mo. Assistant Resident Engineer, Wabash Railway.

PORTER, JOSEPH F. (January 4, 1888), 205 Market Street, Alton, Ill. President and Treasurer, Alton Light and Traction Co.

REEL, C. GORDON (October 18, 1893), 320 Broadway, Kingston, N. Y. Vice-President and General Manager, Kingston Consolidated Railroad Co.

ROPER, DENNEY W. (October 19, 1898), 139 Adam Street, Chicago, Ill. Electrical Engineer, Chicago Edison Co.

SAXTON, EDMUND (December 1, 1880), 1244 11th Street, N. W., Washington, D. C.; Contractor.

SCHAUB, JULIUS W. (January 4, 1888), 1649 Monadnock Building, Chicago, Ill.; Civil Engineer; Specialty, Bridges and Buildings.

SCHRAMM, OSCAR H. (May 15, 1889), 1209 Union Avenue, Kansas City, Mo.; Steam and Hydraulic Machinery.

SEDDIN, JAMES A. (January 16, 1884), 906 Security Building, Chicago, Ill.; U. S. Assistant Engineer.

SHAW, HOWARD B. (March 1, 1899), University of Missouri, Columbia, Mo.; Professor of Electrical Engineering.

Non-Resident Members.

SMITH, BATHURST (February 15, 1888), Post Office Box 947, Kansas City, Mo.

SNEDDON, JAMES P. (January 20, 1892), Chicago, Ill.
Engineer, Hawley Down-Draft Furnace Co.

SPALDING, FREDERICK P. (November 21, 1900), University of Missouri, Columbia, Mo.; Professor of Civil Engineering.

STUART, ALFRED A .(April 6, 1892), Niagara Falls, Ontario, Canada.
Manager for M. P. Davis.

VAN RAVENSWAAY, LUDWIG F. (May 20, 1903), Collinsville, Ill.

WAGNER, HERBERT A. (May 1, 1895), Times Building, New York City; Mechanical and Electrical Engineer.

WILLIAMS, WALTER SCOTT (April 21, 1897), University of Missouri, Columbia, Mo.; Instructor in Civil Engineering.

WOERMANN, JOHN WILLIAM (February 3, 1892), 1115 Monroe Street, Peoria, Ill.; In charge of Waterway Surveys from Chicago to Mississippi River.

YEATMAN, POPE (May 1, 1889), Randfontein, Transvaal, South Africa; Mining Engineer, Randfontein Estates Gold Mining Co.

RECAPITULATION.

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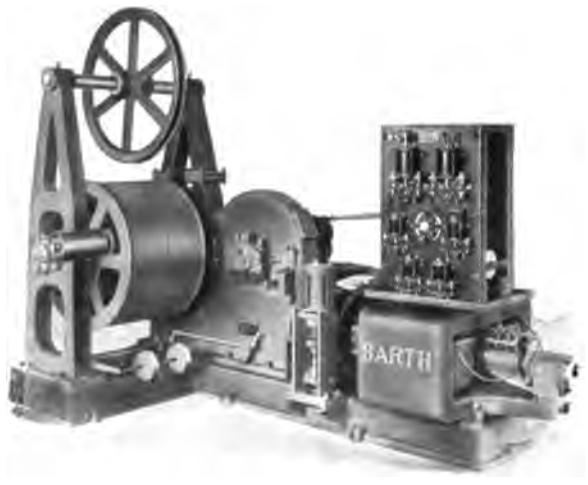

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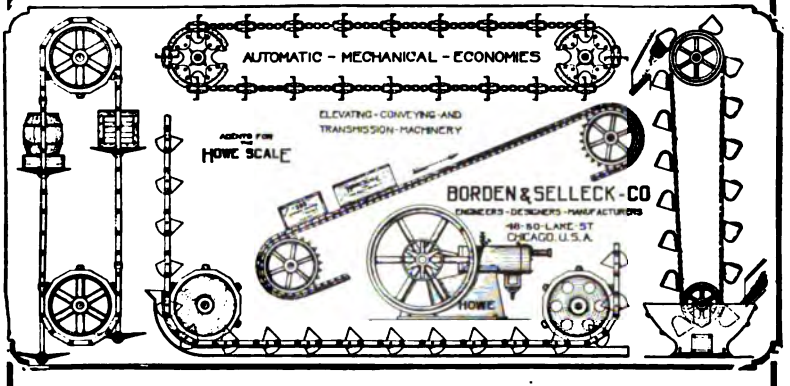

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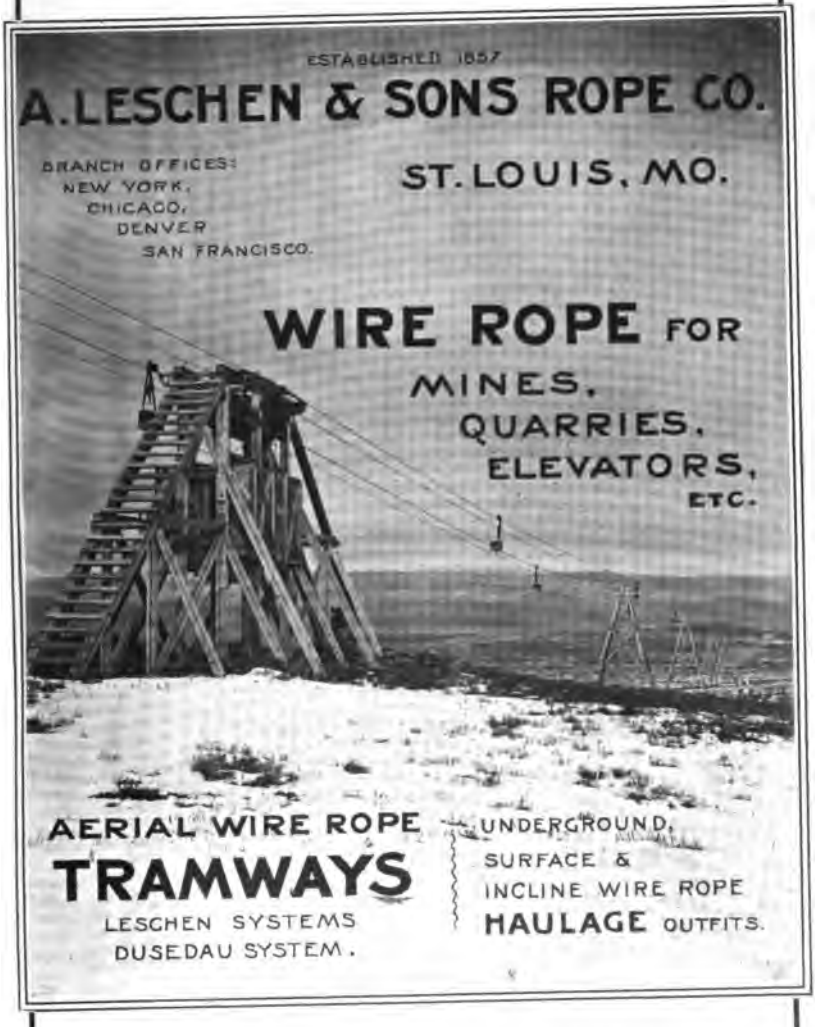

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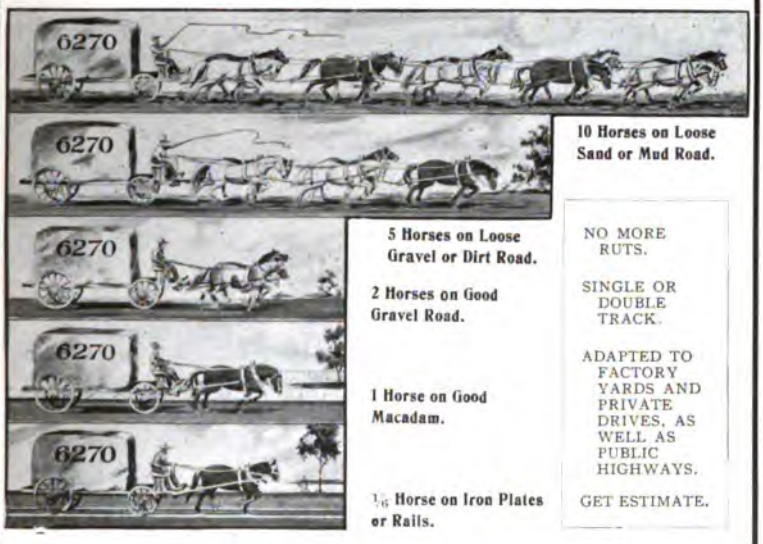

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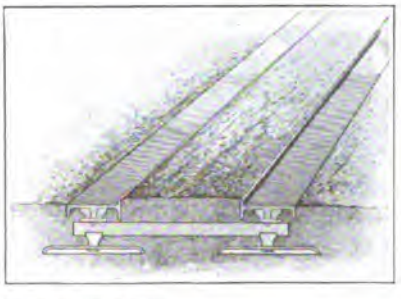

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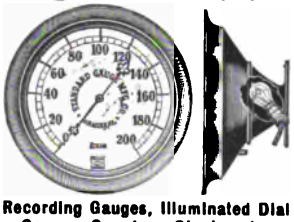

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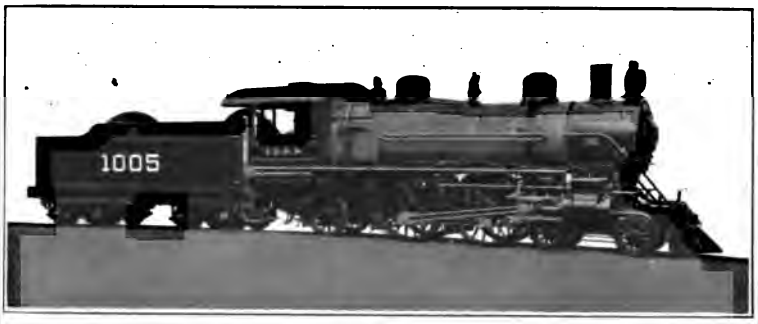

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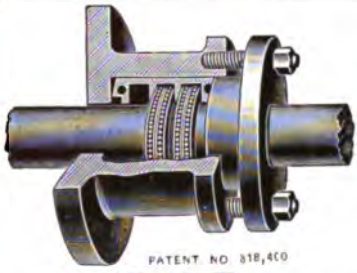

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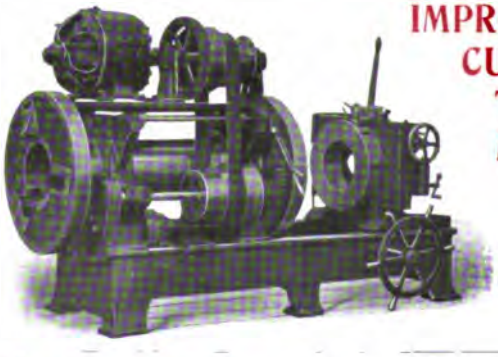

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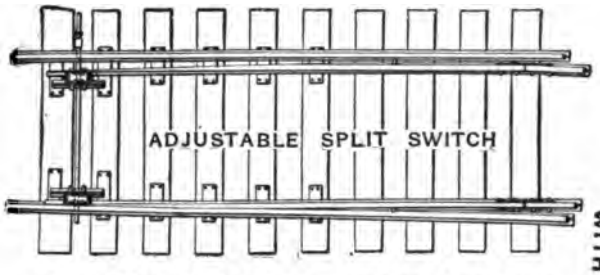

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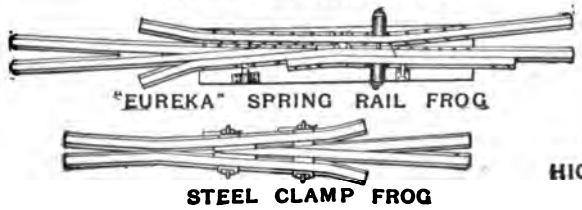

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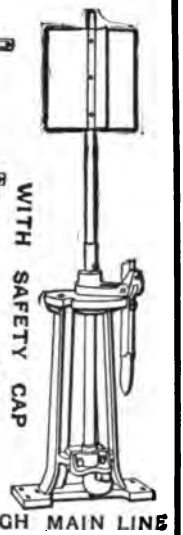

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WORLD'S FAIR COMMITTEE

In Charge of Preparation of

SOUVENIR BULLETIN

— AND —

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